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The state of and prospects for the application of blockchain technology in e-commerce

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ABSTRACT

Whilst e-commerce continues to grow, it has met privacy, trust, and security challenges. Blockchain technology is among the solutions that e-commerce can use to address these challenges. Blockchain technology poses benefits but comes with its challenges. The purpose of this study was to systematically review literature that focused on the state and prospects of blockchain technology in e-commerce. Specifically, the research question is what is the state of the application of blockchain technology in e-commerce? The study conducted searches using four databases (EbscoHost, Science Direct, IEEE Explore, and Jstor) as well as Google Scholar. Exclusion and inclusion criteria were applied in the searches to answer the research question. In total, 25 articles were used for this research and were thematically analysed. The results showed that while there are many benefits in implementing blockchain technologies in e-commerce, there are also challenges. The benefits include an increase in privacy, enhanced security, and minimized costs of transactions. The challenges are tax evasion, black market transactions, and lack of regulation. Results also showed blockchains are used to track product movement and originality. The study's novel contribution is to theory by developing a model for the application, benefits, and challenges of the blockchain technology ecosystem in e-commerce. The study contributes to policy by focusing on sustainable development goals 7 and 9. The research also contributes to the body of knowledge on the application of blockchain. Businesses, scholars, government officials, and other stakeholders can use this study to understand the application, challenges, and benefits of blockchain in e-commerce.

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Introduction

The enactment of the sustainable development goals (SDGs) by the United Nations is meant to assist countries in advancing the well-being of individuals, and businesses, fostering collaboration, and preserving the world for future generations (Nchake & Shuaibu, 2022; Waage et al., 2015; Young et al., 2023). Apart from the practical implementation of the goals, research is argued as another approach to account for and create direction for the SDGs (Waage et al., 2015; Young et al., 2023) through publication and imparting on important policies for development. SDG 7 focuses on ensuring clean and affordable energy is available to all. SDG 9 emphasizes building infrastructure, developing industries, and fostering innovation. The use of information and communication technologies (ICTs) is argued as significant in ensuring that countries progress (Nchake & Shuaibu, 2022) and ultimately attain the SDGs (Son-Turan, 2021; Young et al., 2023). Research has shown that fostering innovations is brought by the development of ICTs, such as e-commerce, that assists in developing industries through possibilities of better marketing, reaching customers, and equipping citizens with buying power (Kabanda & Brown, 2017; Kuntonbutr & Kulken, 2017; Nchake & Shuaibu, 2022; Ribadu et al., 2014).

E-commerce continues to be the fastest-growing industry in the world as well as being revolutionary in changing and advancing how business transactions occur and are managed (Bulsara & Vaghela, 2020). Due to the COVID-19 outbreak, the adoption and use of e-

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commerce platforms have increased exponentially, and businesses have adopted this method of doing business (Kim & Kim, 2022). The pandemic gave rise to e-commerce markets increasing by at least 14.9%, including a relative increase in the market of 0.6% regardless of the pandemic (Alcedo et al., 2022). To facilitate these transactions consumers use their debit or credit cards to make an e-commerce transaction, this is facilitated through a payment gateway (Kim & Kim, 2022).

Using a payment gateway comes at the cost of transaction fees as the payment gateway serves as the intermediary between the consumers and the providers of the transaction (Kim & Kim, 2022). As the volume of transactions increases the fees attached to the transactions increase. This increase causes problems in the e-commerce industry such as a reduction of the profit margin, over-reliance on the providers, information privacy, and security of the gateway system.

Due to the trend of e-commerce expansion, the purchasing behaviors of consumers are evolving (Kim & Kim, 2022). One of the key determinants of the purchase intention of a consumer is trust (Son-Turan, 2021; Thompson et al., 2019). An important factor in gaining consumers' trust is having a trustworthy system for payments in which the parties can identify each other and maintain confidentiality of the transaction (Kim & Kim, 2022). Confidentiality in the transactions addresses the information privacy problem which assists customers in increasing trust in the e-commerce platform. One of the technologies argued to assist with the reduction of transaction fees and increase the level of trust, privacy, and security in e-commerce is blockchain (Mavilia & Pisani, 2020; Son-Turan, 2021).

Blockchain technology allows people the ability to transact and reach a consensus amongst each other without the need for a central authority (Scott et al., 2017). Blockchain does not rely on a single entity to function therefore offering a safe environment in which information can be created and stored (Scott et al., 2017). Blockchain is built on cryptographic algorithms in which the public is the authority by means of the technology being decentralized (Kim & Kim, 2022). Blockchain systems consist of private keys, digital signatures, and public keys which provide users with the ability to make payments and facilitate transactions themselves without requiring additional security (Kim & Kim, 2022). By utilizing the technology of blockchain and implementing it in the e-commerce space, the industry can mitigate the security, trust, and financial implications of the legacy e-commerce model.

Research also speaks to the inadequacies of information disclosure to consumers in the e-commerce space (Song et al., 2022). This lack of disclosure hinders the consumer's perception of the products and intention to purchase, whilst retailers believe that adding additional information comes at the cost of extra burden and monetary cost to them (Song et al., 2022). There is a direct tradeoff between more information disclosure and the costs associated with it (Song et al., 2022). Blockchain technologies can realize information disclosure and reduce the cost of the trade-off as the technology serves as decentralized data storage that cannot be altered (Treiblmaier & Sillaber, 2021). This allows for the information to always be accessible as well as transparent. Transparency is evident with all features of blockchain technologies (Nakamoto, 2008), hence this makes all the information public and gives it the ability to be traced back to view the complete history of products or transactions (Kim & Kim, 2022).

The introduction of blockchain technologies within the e-commerce space allows for many of these issues to be mitigated as blockchain technology is inherently a secured distributed database/ledger that stores information in blocks and cannot be altered or changed (Bulsara & Vaghela, 2020). The use of blockchain technologies in the e-commerce space has not yet been completely explored, and the expectations of it have been somewhat overemphasized (Treiblmaier & Sillaber, 2021). This technology promises to transform the e-commerce marketplace and its applications, however, research in this area is scarce (Treiblmaier & Sillaber, 2021).

Other than the benefits that blockchain can bring to the e-commerce market there are also risks involved in using blockchain. Laws and regulations surrounding the use of blockchain are largely unregulated which causes the value of blockchain currencies to be very volatile and unstable (Astuti et al., 2022). Given the presence of anonymity in blockchain, it creates the price to be volatile as users are largely unsure of its exact value, this can be attributed to the lack of government support, therefore, there is no value assured to it (Dey, 2019). Not having standard regulations in place may cause fraudulent activity in the space of blockchain as it can be used as an exchange for currency which could lead to money laundering and illicit dealings, especially in cross-border transactions (Astuti et al., 2022; Ismanto et al., 2019).

Whilst it is advantageous in processing transactions and payments, blockchain is irreversible by nature and can only be refunded by the receiver therefore users have to be extra cautious when transacting (Dey, 2019). The risks involved in using blockchain are evident, however, these risks are common for blockchain regardless of the industry or sector in which it is being used and can be addressed by implementing laws and regulations surrounding the technology (Astuti et al., 2022). The advantages of using blockchain in e-commerce allows for improvement in the sector and can mitigate many issues which currently face the e-commerce industry.

As blockchain continues to develop and its uses continue to be discovered there is a lack of understanding of the technology in the current state (adoption) and prospects (use) of e-commerce and how consumers, as well as retailers, can adopt these technologies (Treiblmaier & Sillaber, 2021). Current literature speaks to the benefits and risks involved with using the technology as well as the concepts of the implementation process in e-commerce. These pieces of literature have the potential to answer pertinent questions about the current state of blockchain in e-commerce in the form of a systematic review. Therefore, the objective of this research paper is to understand the adoption and uses of blockchain technology in the e-commerce sector. Specifically, the research question is *what is the state of the application of blockchain technology in e-commerce?* Within the research question, the research intends to understand how blockchain is applied in e-commerce, and what are the challenges and benefits of using blockchain in e-commerce.

The research contributes to policy by focusing on SDGs 7 and 9 using e-commerce and blockchain as ICTs that advance industrialization and foster innovation. The paper is structured as follows, the next section provides a background with definitions for e-commerce and blockchain, then the research methodology, followed by the findings and discussion and finally the conclusion.

Background to the study

E-commerce is defined as the action of purchasing and selling services and goods over the Internet (Eastin, 2002). The increased use of smartphones and the evolution of wireless networking allowed for the expansion of the e-commerce market (Kim & Kim, 2022). E-commerce offers the convenience of making purchases anywhere and the ability to effectively compare and research products (Jaganjac et al., 2020). E-commerce became a business model worldwide after the introduction of the World Wide Web and has continued to grow (Treiblmaier & Sillaber, 2021). One of the factors that contribute to growth in e-commerce is customer trust in the systems (Kabanda & Brown, 2010).

Customers buying products from e-commerce sites leads to a tremendous amount of data which is vital in analyzing customer buying trends, items on demand, and sales (Guo et al., 2020; Mthembu et al., 2018). The massive amount of data available on e-commerce sites is a source of concern as customer's personal information such as names, contact details, addresses, product preferences, banking information, credit/debit card numbers, and card verification value (CVV) can be accessed by people with malicious intents. Activities such as hacking, spamming, and denial of service (DOS) are linked to security concerns (Petrini & Pozzebon, 2009; Tchao et al., 2021) and may affect e-commerce sites and their customers. Much of the challenge is because of the use of centralized systems which blockchain technology is argued can address using distributed systems that are more secure and offer privacy (Mavilia & Pisani, 2020; Scott et al., 2017).

Hughes et al. (2019) define blockchain technology as a ledger or distributed database that is shared amongst computer networks. This database serves to store information digitally in a manner that guarantees security and trust without the requirement of a third-party entity (Nakamoto, 2008). Blockchain was first described by Satoshi Nakamoto in 2008, explaining the introduction of Bitcoin as a peer-to-peer version that allows transactions of "electronic cash" (Nakamoto, 2008).

The general method in which e-commerce transactions occur after payment is through means of communication for delivery and proof of purchase (Bulsara & Vaghela, 2020; Pollitzer, 2018). These methods rely on the trust and honesty of both retailers and consumers to ensure authenticity and trustworthiness. The communication methods and transaction occurrences give rise to the large amount of data that is required to be stored either locally or cloud-based (Ahmad et al., 2020; Bulsara & Vaghela, 2020). This poses a security threat to all stakeholders involved (Bulsara & Vaghela, 2020).

Blockchain boasts the highest level of security and protection of information and data, once the information is distributed on the decentralized "block" it is encrypted and is made impossible to be hacked or breached (Song et al., 2022). Despite knowledge of the blockchain's abilities and stated benefits, the use of blockchain technologies in the e-commerce space has not yet been completely explored, and the expectations of it have been somewhat overemphasized (Treiblmaier & Sillaber, 2021).

Research Methodology

This research paper will address the research question by using a systematic literature review (SLR) from the interpretive philosophy. Interpretivism is grounded on the belief that we understand the world based on human explanation and engagement and that multiple subjective realities exist in the focus of explaining our world (Walsham, 2006). Our understanding of the world is also biased and the researcher's role is to ensure that sensitivity to possible biases is acknowledged (Klein & Myers, 1999). The interpretive philosophy is combined with the qualitative method as the researchers engage to understand the meanings and views (Pope & Mays, 1995; Walsham, 2006) from the articles analysed for the study.

The analysis of articles as data for a study can be done by narrative analysis, meta-analysis (Siddaway et al., 2019; Sorgenfrei et al., 2014), or systematic literature review (Okoli, 2015). An SLR is a type of a literature review that gathers and evaluates several research publications (studies or articles) methodically (Asongu & Odhiambo, 2019). Systematic literature reviews are used when the intention is to provide a clear picture (current state of application of blockchain in e-commerce) of the field of study and to afford replication (Siddaway et al., 2019). SLRs have their roots in the health sciences since they are beneficial for both empirically based research and theoretical studies (Okoli & Schabram, 2010). SLR has also been used in Information systems to review literature in the field (Okoli, 2015). In terms of publication and data extraction, SLRs in both domains, health, and social sciences seek to eliminate bias (Drucker et al., 2016). Ethics for non-human research was acquired from the Research Ethics Committee (REC) within the School of Business Sciences (SBS) at the university.

The use of literature reviews has also appeared in the International Journal of Research in Business and Social Science (IJRBS) (Idehen & Mayor, 2021; Oyebanjo et al., 2021; Son-Turan, 2021). While the authors engaged with the concept of blockchain technology, their focuses were different. Idehen and Mayor (2021) conducted a review to examine the role of blockchain and its application to combat fraud in SMEs. Son-Turan's (2021) study focused on trust in equity crowdfunding. Oyebanjo et al (2021) review considered the application of blockchain technology for public procurement processes. Idehen and Mayor (2021) and Oyebanjo et al (2021) conducted reviews but not an SLR. While trust is an important aspect in e-commerce and some SMEs may be providers of e-commerce, to date, IJRBS has not had an article that has explicitly examined the adoption and use of blockchain

technology in e-commerce and this article intends to address the journal gap together with the research gap identified in the introduction.

Despite being used to assist in studies that collect empirical data, an SLR can be used as a standalone research that does not have a theory (Okoli & Schabram, 2010) but can develop a model as a contribution to theory (Rowe, 2014). An SLR has a primary goal beyond the research question and this study is anchored on explaining (Rowe, 2014). This SLR not only conducts a review but also provides a snapshot of the transdisciplinary fields of Business, Social Sciences, and Information Systems research by considering the major arguments about the adoption and use of blockchain technology in e-commerce to explain issues that arise given the importance of both technologies to the fourth industrial revolution (4IR) (Kazan et al., 2018).

Data sources and search terms

The systematic literature review was conducted by searching four electronic databases using relevant keywords that are appropriate to the study. The databases consulted were EBSCOhost, Jstor, IEEE explore, and Science Direct, these databases provide a multitude of seminal works in the ICT space. These databases were recommended by a librarian and that is the reason they were chosen (Young et al., 2023). These databases are also reputable therefore increasing the possibility of acquiring high-quality papers for the research (Levy & Ellis, 2006).

The research papers were from the year 2008 onwards as the first seminal work on blockchain was published in 2008 (Nakamoto, 2008). While papers on e-commerce were published before 2008, they are not relevant to the current state of application of blockchain technology which started in 2008. The articles provided are peer-reviewed and accessible through the university library. The web source: Google Scholar was also consulted. Google Scholar (as a search engine) provides works such as dissertations that provide valuable information relevant to the scope of the literature (Siddaway et al., 2019).

The databases consulted were searched using relevant keywords that appear in the title, abstract, keywords, and body of the article. The keywords were established from the inclusion criteria and used to comb through the relevant databases to find all literature about the research question. Table 1 indicates the databases and keywords used in the search to find all relevant academic literature pertaining to the topic. For the first row, each database is connected to the bullet for the keyword searched. The second row contains several keywords searched in Google Scholar due to the multitude of results it was yielding and the need to refine the searches.

Table 1: Databases and Keywords

Database	Keywords Searched
EBSCOhost	(Blockchain) AND (e-commerce) OR (electronic commerce)
	(State of blockchain) AND (e-commerce) OR (electronic commerce)
Science Direct	(Blockchain in e-commerce) OR (electronic commerce)
	(Implementation of blockchain) AND (e-commerce) OR (electronic commerce)
IEEE Explore	
Jstor	
Web source (Google Scholar)	Current state of blockchain in e-commerce
	Benefits of blockchain in e-commerce
	Risks of blockchain in e-commerce
	Challenges of blockchain in e-commerce
	Application of blockchain in e-commerce
	Implementation of blockchain in e-commerce
	E-commerce Blockchain implementation

Source: Authors

When conducting an SLR there is a multitude of results according to the search terms, therefore, inclusion and exclusion criteria should be clearly defined to get relevant academic works to support and answer the research question (Siddaway et al., 2019; Templier & Paré, 2018). The inclusion criteria were articles that speak to the direct implementation and application of blockchain in e-commerce, studies that look at the benefits of blockchain in e-commerce, studies that look at the challenges of blockchain in e-commerce, seminal works that focus on blockchain and its state in e-commerce, publications from 2008 to current, access to the full article and published in English as researchers are only fluent in the language. The exclusion criteria were papers not published in English, non-peer-reviewed articles, articles that we didn't have full access to, and publications before 2008.

Bias

Any propensity that inhibits a question from being considered objectively is referred to as bias (Smith & Noble, 2014). By encouraging one outcome or answer over another, bias arises in research. Any stage of the research process, such as study design or data gathering, is susceptible to bias (Pannucci & Wilkins, 2010). Conducting an SLR involves using protocols and methods that aim to reduce bias and supplement their findings. Tricco (2008) mentions that when conducting an SLR the following biases are evident, publication, selection, and reporting.

Publication bias: if and when a research paper has ended and the results are not significant or are negative, researchers may choose not to publish the work. To mitigate this bias this research will consult with grey works and dissertations as well as work that has been published in peer-reviewed outlets (Templier & Paré, 2018). It is for this reason that Google Scholar has also been used.

Selection bias: By not being exhaustive in collecting resources for the study there will be an underestimation of results. To address selection bias all available resources should be included (Drucker et al., 2016). By consulting the four different databases along with web-sourced articles (Google Scholar), the selection bias is minimized.

Reporting bias speaks to when an author chooses to report only outcomes that are of interest to them and not the complete study. To address this bias, the researchers paid close attention to the inclusion criteria (Drucker et al., 2016; Templier & Paré, 2018). Apart from attempts to address the three biases in this study, the use of the interpretivist philosophy principle of suspicion (Klein & Myers, 1999) affords the researchers the ability to question arguments presented in the included articles.

Data extraction

The searches conducted on the databases provided 26,577 results (or hits). Systematic literature reviews are known for producing higher results on the first search but selected few articles are used for analysis. For example, the research by Ibidunni et al (2022) had 52,430 hits on the first search but only analysed 127 articles. The study by Mulibana and Rena (2021) had 2,774 hits on the first search and only analysed 44 articles. The research by Hauge et al (2010) had 24,289 results on the first search but only analysed 112 articles. The study by Williams et al (2008) had 227 first search results and only analysed nine articles. The study by Mwita (2022) had 87 first search results and only analysed 22 articles. For SLR, researchers are urged not to focus on arriving at a high number of articles but using practical screening, filtering, and inclusion criteria that are thorough (Okoli, 2015; Siddaway et al., 2019; Templier & Paré, 2018).

The 26,577 results had to be screened and scanned for duplicates. The Google Scholar results had to be assessed for full-text articles as well as English language articles only according to the inclusion and exclusion criteria. The initial filter was for duplicate results which eliminated 464 results. After scanning the titles 137 articles were selected for eligibility. A further 89 articles were excluded based on their abstracts. Furthermore, the remaining 48 articles were assessed for content, 23 of those were excluded with reasons after reading the articles' abstract, introduction, and conclusions, and 25 of these articles were used in this article. Figure 1 (PRISMA flow) illustrates the selection process of the articles and exclusions thereof.

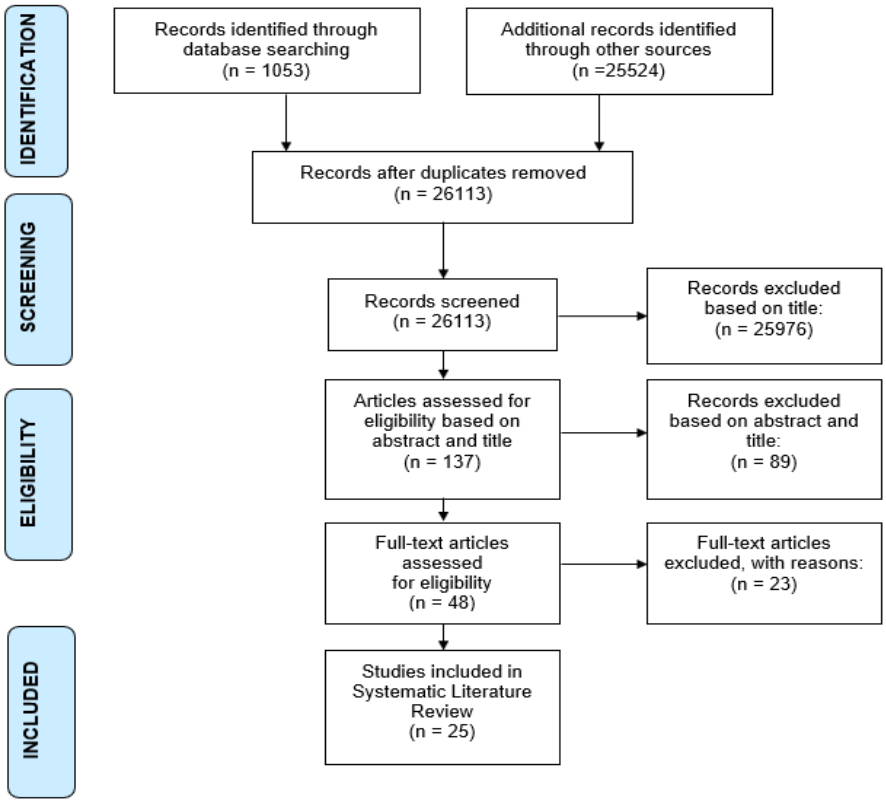


Figure 1: PRISMA flow; *Source*: Authors

From the included research, the researchers set out a criterion to assess the articles for their quality. The quality of the articles was assessed on a scale of 1-3 (1=low, 2=medium, 3= high). Okoli (2015) states that papers need to be scored for quality appraisal as part of the steps of a systematic literature review. Therefore the 25 included papers were quality appraised with the lowest scale having six papers, followed by 14 papers for medium, and five papers for high. Such information is found in Table 3.

Data analysis

To analyse the data of this systematic literature review, thematic analysis was followed due to its flexibility and reflexivity (Clarke & Braun, 2013). This method of analysis is utilized in qualitative research and gives insight into the collected data (Braun & Clarke, 2006; Nowell et al., 2017). We follow the six steps identified by (Braun & Clarke, 2006) in conducting thematic analysis. This research used the inductive approach to theory building by developing themes from the 25 included research papers (Clarke & Braun, 2013).

The first and second steps of thematic analysis began with each author reading a single article and coding a sentence or paragraph based on what the focus was while guided by the words used in the search terms. After coding the first article, the authors met for a discussion, and we noticed that we had a 90% agreement in the codes we used. The authors reached a consensus on the codes that were different by incorporating them into the list of codes. The authors continued by reading the second article and coding until we finished with all 25 included articles. The authors could conduct discussions from time to time when differences emerged, or some papers were not clear using Microsoft (MS) Teams.

Table 2: Coding table

Theme	Description	Sub-themes
Adoption	Adoption of blockchain technologies in e-commerce	Used to track product movement, and Used to prove the originality of products.
Benefits	The benefits of using cryptocurrency or blockchain in e-commerce	Handling of transactions Improved security Improved information (and privacy), and Transparency (or traceability)
Challenges	The challenges of using cryptocurrency or blockchain in e-commerce	Laws and regulations are not enacted. Blockchain requires a high amount of computing power and storage. Possibilities for tax evasion, and Volatility of blockchain

Source: Authors

Once all papers were coded, in the third step, the authors convened with their list of codes and began to search for themes by grouping codes that were similar to the arguments they were raising. The process continued until all 13 codes were grouped into different themes. The authors then proceeded to review the themes by considering internal homogeneity and external heterogeneity among the codes as the fourth step. The reviewing of codes leads to the processes of defining themes and sub-themes as presented in Table 2 which is the fifth step. The themes; of adoption (and use), benefits, and challenges; were used to categorize findings from papers in these relevant themes. The sixth step is the development of a manuscript which this article stands for.

Findings and Discussion

To understand the current state of blockchain adoption in e-commerce, the study engages with the themes of adoption, benefits, and challenges of blockchain. Within the themes, sub-themes are used to expand on the key arguments. Table 3 presents the 25 articles and a bullet point of the arguments raised. In SLR, the use of Tables is considered as data that shouldn't be placed in the appendix but as part of the manuscript (Okoli & Schabram, 2010; Rowe, 2014; Siddaway et al., 2019; Wolfswinkel et al., 2013).

Table 3: Included articles with their quality assessment and key arguments

No	Author	Quality assessment	Benefits or challenges of blockchain in e-commerce
1	(Subramanian, 2018)	2	The functionality of marketplaces is not the responsibility of the firm but is now replaced by nodes. Provides unmodified information to buyers and sellers. Transaction Costs Minimized. More secure transactions. Cyberattacks are reduced. The e-commerce site discussed is Openbazaar.
2	(Schellekens, 2019)	2	Blockchain is resource-intensive. Computer time.
3	(Treiblmaier & Sillaber, 2021)	3	Improved Security and privacy. Improved traceability. Unclear on regulations and compliance. Blockchain is expensive. Organizational changes.
4	(Tsukerman, 2015)	2	Serve as a currency that is not backed by the government. Potential for tax evasion, black market transactions, minimal legislation.
5	(Deng & Ouyang, 2022)	1	Solves information asymmetry between parties. lowers transaction costs. increase in efficiency. Conditions to implement blockchain in the cross-border supply chain.
6	(ZhuanSun et al., 2021)	3	Multiple parties storing data via distributed ledger ensures the security of transactions. Authentic Ratings. Blockchain technology is not yet completely developed to explore all the possible applications in e-commerce. The evolution of blockchain in e-commerce needs to be studied in-depth. Evolutionary impact forms a systematic perspective.
7	(Liu & Guo, 2021)	1	Blockchain technology allows for efficient supply chain management in terms of e-commerce and delivery, to improve overall product quality. This improves profits and the quality of the brand.
8	(Kim & Kim, 2022)	2	Payments can occur more efficiently and quickly. The e-commerce site studied is Amazon.
9	(Dutta et al., 2020)	2	Monitoring of fraudulent activities, ensuring transparency, real-time transactions, and smart contracts. Blockchain is open source, decentralised, and immutable. Enhanced Security. Payment systems. Risk management. Data security SCM. Laws and regulations are not clear. Costly to develop and implement. Research on the prototype implementation.
10	(Wang, 2021)	2	Higher sense of security. Protect consumer's privacy. Protection of sensitive information.
11	(Bao & Feng, 2020)	2	Tamper-proof and traceable. Developing infrastructure is expensive and time-consuming.

12	(Liyanage et al., 2022)	2	Remove the need for a third-party intermediary when conducting transactions, and therefore be able to view products in real-time.
13	(Joo et al., 2020)	3	Permanent public record of all transactions processed. The technology requires trust for it to be used effectively. Further familiarization is required for this technology to be adapted.
14	(Rossi & Tuunainen, 2017)	2	Provides an audit trail. Need for research on theoretical and practical perspectives of blockchain. Better understanding of the risks and opportunities will create better services.
15	(Cristina, 2021)	2	Blockchain technology offers data security, purchase history, new and improved payment methods as well as cheaper transaction fees. Development for the application is still in progress.
16	(Xuan et al., 2020)	3	Mitigates data breaches and cyber-attacks, this in turn ensures the company and its platform are safe to transact on leading to increasing brand reputation. Information disclosure and transparency of product information leading to increased brand reputation. Public trust in using blockchain.
17	(Shi et al., 2021)	2	Traceability Transparency Permanent record Low information-sharing cost Sustainability Broad e-commerce platforms
18	(Pushpalatha et al., 2022)	2	Smart Contracts Trust Transparency The e-commerce site is onKart.
19	(Xiao et al., 2021)	1	High Security Transparency Traceability Build a trust and management system for users to build relationships.
20	(Tredinnick, 2019)	3	Non-controlled by central authorities. Security Robust Transparent Faster process Price of crypto, pump, and dump Power consumption Regulations
21	(Sial, 2019)	2	Digitization of assets, processes, transactions, and permanent data storage Storage requirement Blockchain is energy intensive
22	(Alam et al., 2021)	1	Smart contract Reduce transaction processing.
23	(Lu et al., 2022)	1	Control of counterfeiting Disclose product quality information. Alibaba to prove originality. Blockchain can be trusted.

			Reduce selling price. Shift consumers to purchase genuine products.
24	(Mut-Puigserver et al., 2020)	1	Proof of delivery Efficient
25	(Cai & Zhu, 2016)	2	Secure Permanent Incorruptible Irreversible A large amount of computing function.

Source: Authors

The conversation about blockchain use in e-commerce happens in conferences and journals. Of the 25 articles included for analysis, eight came from conferences and 17 from journals. The Institute of Electrical and Electronics Engineers (IEEE) has the majority of the conference outputs meaning the discussion of blockchain use is still treated as a technical technology in conferences.

Uses of blockchain in e-commerce

When looking at the application and implementation of blockchain technologies in e-commerce many use cases have been studied in theory however the practical or real-life use cases are not as well documented (Joo et al., 2020; Rossi & Tuunainen, 2017). (Kim & Kim, 2022) studied blockchain technology as a method of payment in the e-commerce sector. Their model outlines the benefits of using blockchain in the e-commerce sector, how blockchain removes the need for third-party payment gateways, and how it minimizes transaction fees.

Applying blockchain technology in the e-commerce sector provides different uses and features as opposed to traditional marketplaces. This technology allows for the capability of transactions to be tracked (Subramanian, 2018). In e-commerce, the supply chain is a fundamental aspect of the industry, blockchain technology can be used in this process to ensure a trusted supply chain across a secure network (Deng & Ouyang, 2022). The study (Deng & Ouyang, 2022) developed a model for supply-chain using blockchain technologies and found that using these technologies would be more profitable and valuable both economically and environmentally. Another study by (Lu et al., 2022) had similar results.

Blockchain technology has also been found to be used in e-commerce as a means of digital signatures or smart contracts (Alam et al., 2021; Pushpalatha et al., 2022). The nature of blockchain considers complete transparency across distributed ledger, blockchain technologies can be used for smart contracts as (Dutta et al., 2020) findings reveal.

In the same focus on transparency and tracking of products, the quality, and originality of products are also crucial as (Liu & Guo, 2021; Lu et al., 2022) found. (Lu et al., 2022) engaged with the e-commerce platform Alibaba and argued it uses blockchain technology to achieve its uses. Alibaba requires their sellers to upload designs on a blockchain system that was developed; this system ensures that product designs that are uploaded are original therefore granting complete transparency to consumers and ensuring trust as well (Lu et al., 2022).

The benefits of using blockchain technology in e-commerce

According to research, the implementation of blockchain technologies in e-commerce is apparent due to the benefits this technology provides in its implementation (Lu et al., 2022; Subramanian, 2018; Treiblmaier & Sillaber, 2021). Researchers speak to the different benefits of blockchain itself and blockchain in the e-commerce sector. However, after synthesizing the literature, the benefits of blockchain can be identified as engaging in transactions, security, information, and transparency (or traceability).

When using blockchain in e-commerce, one major benefit that it poses is how this technology handles transactions. Blockchain technology removes the need for a third-party intermediary to handle transactions (Liyanage et al., 2022; Treiblmaier & Sillaber, 2021). Once a transaction has occurred it is completely traceable and tamper-proof. This technology ensures that payments and transactions can happen more efficiently and quickly (Subramanian, 2018). This ensures that transactions are more secure, platforms are more efficient and there is complete trust from a consumer.

Blockchain technology in e-commerce ensures better security of the platform as in nature, the blockchain technology is immutable and tamper-proof, this ensures cyber-attacks are reduced and a heightened sense of consumer privacy and security (Wang, 2021). With the information being on a distributed ledger, it also ensures complete transparency of information and traceability (Cristina, 2021; Subramanian, 2018; Tredinnick, 2019; Treiblmaier & Sillaber, 2021; Xiao et al., 2021).

Blockchain technology solves the information asymmetry issues as well as the non-disclosure of information. By having e-commerce platforms use blockchain technologies, the nature of the technology is such that every piece of information on every node is recorded and traceable for users and consumers to see (Deng & Ouyang, 2022; Lu et al., 2022; Shi et al., 2021; Wang, 2021; Xuan et al., 2020). This technology ensures that multiple parties store data across a distributed ledger which ensures information validity. When transactions and purchases occur on e-commerce platforms, blockchain technologies can be used to ensure that ratings of products and reviews are authentic as they are traceable (Song et al., 2022). This technology can also mitigate fraudulent activities and monitor them to ensure further security and transparency as argued (Wang, 2021).

The concepts of traceability and transparency while different in nature, coincide with and complements one another in terms of blockchain and e-commerce (Bao & Feng, 2020; Shi et al., 2021; Treiblmaier & Sillaber, 2021; Xiao et al., 2021). As blockchain technologies are set up to be traceable (regardless of the transaction), it ensures that all processes that occur on the system are indeed transparent (Rossi & Tuunainen, 2017) as well as leading to an efficient system (Mut-Puigserver et al., 2020).

The challenges involved with using blockchain technology in e-commerce

The implementation of blockchain technologies in e-commerce does not come without its' own set of challenges. Whilst the technology provides numerous benefits in the e-commerce sector there are a few considerations that need to be made before implementing these technologies. One of the main concerns surrounding the technology at large is compliance, policy, and

regulations (Tredinnick, 2019; Treiblmaier & Sillaber, 2021). Legislation regarding the technology and regulations for its use is lagging behind the development of the technology itself (Treiblmaier & Sillaber, 2021) as governments are still enacting laws to guide the use of blockchain. Since its inception in 2008, blockchain hasn't been formally supported by governments (Tsukerman, 2015) leading to limited to no laws and regulatory requirements that are unclear (Dutta et al., 2020; Schellekens, 2019; Tredinnick, 2019; Treiblmaier & Sillaber, 2021).

Implementation of the technology incurs massive costs and resources for the technology to be used effectively (Bulsara & Vaghela, 2020; Dutta et al., 2020). With new technology and new platforms, consumers would have to register new accounts and identities which are time-consuming and tedious for companies to identify their consumers. Whilst these systems work and flourish in theory, implementing blockchain systems and technologies requires a great amount of work and time (Bao & Feng, 2020; Liu & Guo, 2021). Blockchain technology in its anonymity creates avenues for individuals to pursue fraudulent financial activities such as black-market transactions and tax evasion as this technology serves as its own currency and is not dependent on the government (Tsukerman, 2015).

This technology currently has many applications and uses. However, the technology is not yet completely developed and still has the potential to be developed further to explore all possible applications (Cristina, 2021; ZhuanSun et al., 2021). Apart from developing the technology, the infrastructure required for the technology is expensive to develop (Bao & Feng, 2020; Dutta et al., 2020) and requires large amounts of computing power which consumes more energy as opposed to traditional e-commerce functions (Cai & Zhu, 2016; Schellekens, 2019; Sial, 2019; ZhuanSun et al., 2021). Not only does blockchain require a large amount of power, but also it requires large amounts of storage space to store the blockchains. This type of storage space required is expensive to set up and maintain for businesses (Alam et al., 2021; Sial, 2019).

Blockchain, such as cryptocurrency, is not controlled by governments, and their prices are set by supply and a pump and dump phenomena, therefore leaving the prices of blockchains very volatile, and reducing users' trust in the technology (Tredinnick, 2019). For the implementation of the technology to be successful, it requires consumer trust (Joo et al., 2020; Lu et al., 2022; Pushpalatha et al., 2022; Xiao et al., 2021; Xuan et al., 2020).

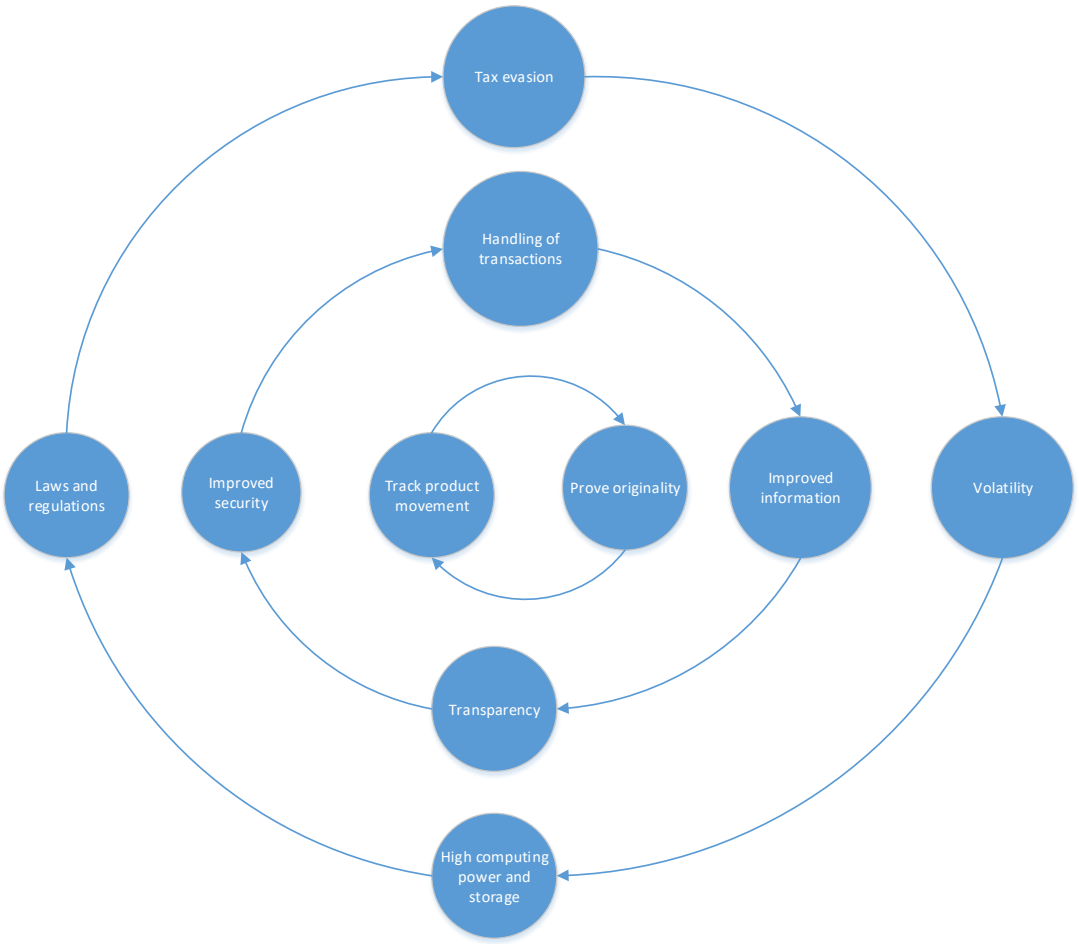


Figure 2: Applications, benefits, and challenges of the blockchain ecosystem in e-commerce**;** *Source:* Authors

The study develops a model on the application, benefits, and challenges of blockchain ecosystem in e-commerce which is a novel contribution to theory. The model, Figure 2, depicts the interaction among the applications, benefits, and challenges as processes

because the relationship enacted among the sub-themes is that of dependency. Ideally, the model argues that for blockchain to find widespread adoption and use (inner circle), the challenges must be addressed (outer circle), and the benefits be realized (middle circle). For example, in the process of ensuring that products can be traced, and information flow is improved, the e-commerce site can prove product originality and the site becomes transparent to its customers. However, despite the ability to handle transactions and improved security, laws and regulations are unclear which affords scrupulous customers to engage in tax evasion activities. The high computing power and storage may be another reason why laws and regulations are unclear as the excessive use of energy requires governments to enact laws that support affordable and clean energy to meet SDG 7 (Waage et al., 2015). Such a process takes time and hence the delay in the creation of the laws and regulations indirectly leads to the volatility of the blockchain.

Conclusions

Despite the development in e-commerce, trust among its customers is a challenge and that is due to privacy and security issues. Blockchain technology is argued to be a distributed system that ensures security among its users leading to the privacy of information and offering the ability to increase customers' trust. As many examples of implementation of blockchain technologies exist in theory, there is very little literature to speak to the practical and real-life scenarios of blockchain technology in the e-commerce industry. In this systematic literature review, blockchain technology was looked at in the e-commerce industry. This review has provided valuable insights into the application, benefits, and challenges of blockchain technology in the e-commerce sector.

Blockchain technology provides the ability to track product movement and prove the originality of products. Alibaba employs blockchain technology to prove the originality of products from its suppliers. Blockchain provides many benefits to the ecommerce industry such as ensuring more secure, transparent, and traceable transactions across e-commerce fields. This technology ensures efficient, transparent, and effective information disclosure. However, it does not come without its challenges. For blockchain technology in e-commerce to be successful, the implementation of this technology must outweigh its challenges.

The challenges of blockchain technology as related to e-commerce are the lack of laws and regulations, and the demand for high computing power and storage which affects the need for clean energy as required by SDG 7. Furthermore, blockchain is volatile which may lead to tax evasion by some scrupulous customers. This systematic review outlines that the current state of blockchain technology in e-commerce is that there is a lot of room for development of the technology.

The study's novel contribution is to theory by developing the model on the application, benefits, and challenges of the blockchain ecosystem in e-commerce. This model is unique as it doesn't focus on factors only but includes the application of the technology. The study also contributes to policy by engaging with SDGs 7 and 9 on advancing industrialization and fostering innovation through the adoption of blockchain in e-commerce and the need for clean energy. The study contributes to the body of knowledge on e-commerce as a well-established industry.

Practically, businesses, scholars, government officials, and other stakeholders can use this study to understand the applications, challenges, and benefits of blockchain in e-commerce. For example, government officials and businesses can consider the option of accepting the adoption of blockchain in business transactions conducted online as it affords the ability to track items and reduce the demand for black market products. Businesses, scholars, government officials, and other stakeholders will practically enjoy the benefit of adopting and using blockchain technology which will afford them the right to privacy as stipulated in the Protection of Personal Information Act (POPIA) in South Africa and General Data Protection Regulation (GDPR) that is used in Europe.

The main limitation of conducting a systematic literature review is that important articles may be missed because either the database they have been published in is not used for the study or the year they were published is not considered. That is, irrespective of how efficient the database search is, and the inclusion criteria are, some articles that are important in the field may be overlooked. Such challenges may also arise because the abstract of an article is missing important search terms that are part of the inclusion criteria. The use of evidence, publication, selection, and reporting biases are meant to address such challenges. However, certain limitations persist in systematic literature reviews.

In this systematic literature review, it was found that the majority of the implementation models were theoretical models, future research could investigate real-life implementation of blockchain systems in the e-commerce field besides the Alibaba, Amazon, OnKart, and Openbazaar examples provided. For example, future research could conduct case studies or surveys on the trend of blockchain technology in specific e-commerce platforms.

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