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# Impact of Blockchain technology on E-Commerce Website

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**Abstract:** *Blockchain-based technologies are predicted as major disruptors for numerous business applications and pro Blockchain cesses, which bears huge implications for e-commerce. Given the ability of blockchain and related technologies Distributed Ledger Technology to create so-called "trustless systems" with idiosyncratic properties, various business models and established processes that have emerged over the years to ensure trust, reliability and enforceability in business-to-consumer (B2C), business-to-business (B2B), business-to-government (B2G) and consumer-to-consumer (C2C) relations need to be questioned and potentially adjusted. Blockchain has the potential to shake the foundation of e- commerce by enabling exchange relations that are trustless and operate without dedicated intermediaries or even central authorities in the case of permissionless blockchains. Furthermore, the exchange of information and value between companies and consumers might change considerably by enabling unified access to immutable data along the entire supply chain. In this paper, a framework and 19 high-level research questions are developed to inspire researchers to closely investigate the potential impact of blockchain on e-commerce. The main categories include (a) technological, (b) legal and (c) organizational and quality issues as well as (d) consumer issues. This paper illustrates how blockchain potentially impacts different elements of e-commerce in these respective areas..*

**Keywords:** Blockchain, Distributed ledger technology, E-Commerce, Research framework

## I. INTRODUCTION

The concept of blockchain was first described in 2008 by Satoshi Nakamoto, who introduced Bitcoin as a peer-to-peer electronic cash system (Nakamoto, 2008). As Narayanan and Clark (2017) point out, most of the technologies presented in the paper had been developed in the decades preceding the publication, but it was their novel combination that finally led to a solution for the double-spending problem that denotes the multiple spending of the same digital asset (DeSantis et al., 2008). Most noteworthy, already in 1983, David Chaum presented a solution in which so-called blind signatures (i.e., the content of a message is disguised prior to signing it) allow for an untraceable payment system (Chaum, 1983). This system, however, was still dependent on a central authority. In the years following the publication of Bitcoin, the concept of blockchain and related technologies was mainly discussed in dedicated computer science and cryptography communities without having a major impact on society, industry or the economy. To some extent, this resembles the humble beginnings of the Internet, which are rooted in the ARPANET, an early packet switching network based on TCP/IP that was developed at the end of the '60 s and was initially used primarily for communication and resource sharing in academic and military institutions (Oppliger, 1998).

Public awareness of blockchain increased considerably around the year 2015, when not only the exchange value of Bitcoin started to soar, but several books were published that mainly targeted practitioners and clearly outlined the potential economic value of the technology (Swan, 2015; Tapscott and Tapscott, 2016). Soon after that, widely read journals such as Nature, Harvard Business Review and MIT Sloan Management Review started to scrutinize the business value of blockchain (Chapron, 2017; Iansiti and Lakhani, 2017; Tapscott and Tapscott, 2017). At around the same time, the first publications and calls for papers in information systems and business-related journals were published (Beck et al., 2017; Fanning and Centers, 2016), and the focus of attention shifted to the question of how business value can be generated from blockchain technology (Bahga and Madisetti, 2016; Onder and Treibl¨ maier, 2018). In the meantime, several authors have suggested blockchain-based research agendas for areas such as governance (Beck et al., 2018), supply chain management (Treiblmaier, 2018) and the sharing economy (Hawlitschek et al., 2018) and have developed

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frameworks that differentiate various levels of analysis (i.e., users and society, intermediaries, platforms, firms and industries) (Risius and Spohrer, 2017).

Blockchain was readily embraced by the industry, which led to exaggerated expectations during the hype while the interest in exploring profitable use cases of blockchain has continued unabated. When it comes to supply chain solutions, industry giants with different roles in extensive value networks such as IBM, Maersk, Carrefour and Walmart all explore how blockchain can lead to more transparency, faster processing and the elimination of paperwork in an industry that is plagued by fraud and suffers from substantial inefficiencies (O'Brien, 2019). Amazon recently filed a patent for a blockchain-based authenticator to verify the authenticity of customer goods (Joshi, 2020). Overstock.com founded a subsidiary, Medici Ventures, with the mission to advance blockchain technology (Pollock, 2019). More specifically, their goal is to facilitate peer-to-peer transactions without any major intermediaries. Another example is the envisioned $870 million free trade zone for e- commerce in Dubai named Dubai CommerCity that goes along with Dubai's vision to become the "happiest city on earth" by leveraging blockchain technology for government efficiency, industry creation and international leadership (UAE Government Portal, 2020). According to Research and Markets (2020), the global blockchain market will grow from USD 3.0bn in 2020 to USD 39.7 bn by 2025 at a compound annual growth rate (CAGR) of 67.3%. Across all application areas, they further predict that the retail and e-commerce segment will exhibit the highest growth rates. Fueling this development, the COVID-19 pandemic has led to an increase in cryptocurrency payments during the time of crisis (Chamola et al., 2020).

Recent research indicates that while blockchain will also have a major impact on e-commerce (Subramanian, 2018), it remains under- researched (Liu and Li, 2020). E-commerce can be succinctly defined as "buying, selling and marketing on the Internet" (Targett, 2001, p. 4). A more detailed description can be found in Turban et al. (2004, p. 3): "E-commerce describes the process of buying, selling, transferring or exchanging products, services and/or information via computer networks, including the Internet". Given the ongoing evolution of blockchain applications and their potential implications for commercial organizations and customers alike, pending issues related to e-commerce in several areas need to be addressed. These areas include the potential impact of blockchain, the role of virtual assets, the emergence of new topics and the design and deployment of systems:

- How can blockchain and related technologies impact e-commerce?
- How can virtual assets (i.e., digital representations of value such as cryptocurrencies), as a salient application of blockchain, impact e- commerce?
- What are salient research topics that need to be tackled in order to analyze, explain and predict the impact of blockchain and related technologies on e-commerce?
- How can e-commerce systems be designed that capitalize on the strengths of blockchain?

Although the term "blockchain" has received most attention in the media, this analysis considers all systems based on Distributed Ledger Technology (DLT) (Treleaven et al., 2017) since the focus of this paper is on generic features and not on a particular data structure. Accordingly, the term e-commerce also includes related technologies such as m- commerce (mobile commerce) (Clarke III, 2008).

Blockchain promises to enable a transformation from the "Internet of information" to the "Internet of value" (Tapscott and Euchner, 2019) via the transfer of valuable virtual assets as digital information between peers, which can potentially affect many intra- and inter-organizational processes related to e-commerce. Research in this particular area is scarce, but so-called Darknet markets and several scientific publications have already indicated the disruptive potential of "decentralized blockchain-based electronic marketplaces" (Subramanian, 2018), which denotes, in a wide sense, places where buyers and sellers directly interact by electronic means (Wang and Archer, 2007, p. 91).

In this paper, 19 research questions regarding the impact of blockchain on e-commerce are systematically derived by matching key elements of e-commerce with potentially disruptive characteristics of blockchain. This paper starts with a short discussion of the relevant characteristics of e-commerce and blockchain, respectively. Next, technological, legal and organizational and quality issues as well as consumer issues are discussed, and research questions are derived that are intended to serve as starting points for further studies. Finally, all questions are summarized into a comprehensive research framework, and the potential implications for academia and the industry are discussed, followed by several limitations and a brief outlook on future research.

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## II. E-COMMERCE AND BLOCKCHAIN

It took the Internet several decades to transform from a network that was primarily used for communication purposes at and between military and educational institutions into a technological platform that was able to host and realize commercial applications (Mueller, 2002). However, after the introduction of the World Wide Web (Berners-Lee et al., 1994), it took only a few more years before commercial websites were soaring (Mukhopadhyay et al., 2008; Tian and Stewart, 2006) and e-commerce became a worldwide business model, with retail e-commerce sales amounting to 4.89tn US dollars in 2021 with an expected growth of up to 6.39tn US dollars by 2024 (Statista, 2021b), which has been amplified by the global COVID-19 outbreak as indicated by early research (Hasanat et al., 2020). In comparison, the total market capitalization of cryptocurrencies amounted to 566.26bn US dollars in 2017, 128.78bn US dollars in 2018, 237.1bn US dollars in 2019 and 758.06bn US dollars in 2020 (Statista, 2021a), showing a strong decline after the 2017 hype, but also a rapid recovery and growth afterwards. Payments with cryptocurrencies only have a 2% share of digital payment transactions, but are growing in importance (Markham, 2019).

The following sections briefly describe the advent of e-commerce and highlight several important research topics that have emerged. Next, relevant developments in the area of blockchain are summarized that even surpass the speed of the e-commerce era with respect to expectations and, to an extent, also market adoption. The focus of the discussion lies particularly on those characteristics of blockchain that have the potential to significantly impact e-commerce.

### 2.1. E-Commerce Characteristics

Various review papers exist that systematically classify and structure the existing e-commerce literature. One of the earliest e-commerce review papers authored by Ngai and Wat (2002) structures the domain into different areas: (a) applications (e.g., inter-organizational systems, payment systems, marketing), (b) technological issues (e.g., security, network technology, support systems) and (c) support and implementation (e.g., public policy, corporate strategy). Subsequent e-commerce review papers have focused on topics such as trust building for consumer relationships (Papadopoulos et al., 2001), e-commerce in specific geographical regions (Vaithianathan, 2010), online consumer behavior research (Hwang, 2016; Thomas et al., 2019), recommendation systems (SLi and Karahanna, 2015) and reference architectures (Aulkemeier et al., 2016). Besides identifying the major success factors of e-commerce, these frameworks are of interest for both practitioners and academics since they help to identify criteria that might help to promote the widespread adoption of e-commerce and provide guidelines on how to develop successful applications.

Numerous academic papers rigorously investigate the antecedents of successful e-commerce. Kauffman et al. (2010) illustrate how information technologies have changed the face of e-commerce through the creation of business network-based value and conclude that the industry underwent a digital transformation. In their analysis of the intensity of e-business adoption and its impact on business performance, Wu et al. (2003) develop a model in which firm characteristics such as top management emphasis, organizational learning ability, customer orientation and competitor orientation as well as the competitive environment, measured by customer power and normative pressures, are adoption antecedents and success factors. The actual impact on performance outcomes is moderated by market and technological uncertainty. Roberts and Toleman (2007) extend this model by adding the regulatory environment (i.e., e-government services and e-government compliance processes), the size of the firm and supply chain power, which also includes supplier power, as additional antecedents. Various additional studies are based on theoretical models such as the Technology Acceptance Model (TAM) (perceived usefulness, perceived ease of use) and Unified Theory of Acceptance and Use of Technology (UTAUT) (performance expectancy, effort expectancy, social influence, facilitating conditions) (Pavlou, 2003; Shih-Tse Wang and Pei-Yu Chou, 2014; Wirtz and Gottel, 2016¨ ) and differentiate between decision-maker characteristics, innovation characteristics and environmental characteristics (Ching and Ellis, 2004) or include additional consumer-specific variables, such as social influence, trust, perceived risk and satisfaction (Guzzo et al., 2016). Taken together, the existing body of academic literature that has been published over a period of two decades allows for a comprehensive understanding of the factors that contribute to effective and efficient e-commerce practices.

### 2.2. Blockchain Technology Characteristics

According to Mougayar (2016, p. 4), blockchain can be defined from three different angles. Technically, it is a database that maintains a distributed ledger that can be inspected openly. Business wise, it is an exchange network for moving

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transactions, value and assets between peers without the assistance of intermediaries. Seen through a legal lens, it validates transactions, thereby replacing previously trusted entities. Since the focus of this paper is on the specific characteristics of blockchain rather than on a specific algorithm or technology, related technologies that are frequently labeled as DLT or trustless systems are also considered. DLT is an umbrella term that refers to technologies that distribute information in either private or public ledgers across several nodes (Crosby et al., 2016). So-called trustless systems do not fully eliminate the need for trust, but rather they minimize the level of trust needed from any single participant (Wright and De Filippi, 2015). This is done by providing various cooperation incentives for actors that reward the kinds of behavior that benefit the system as a whole (Bohme et al., ¨ 2015; Moser and B¨ ohme, 2015¨ ). Following widespread practice in the academic literature, the remainder of this paper uses the term "blockchain" as a synonym to encompass this set of related technologies; the reader should be aware, however, that this naming rather follows the typical usage of the term and is not a precise delimitation to other terms. This does not matter so much in the context of this paper, since we focus on well-understood characteristics common to the set of underlying technologies as opposed to any specific manifestation or implementation of these technologies in the constantly evolving socio-technical ecosystem.

Blockchains allow their users to maintain a common database without the need for a trusted central controller or mutual trust, such that any participant may enter or leave the system at any time (Bohme ¨ et al., 2015). Algorithms establish the chronological order of time- stamped entries by cryptographically linking individual transaction sets ("blocks") to each other through cryptographic hashes (Chaffey, 2007). Each block is linked to its predecessor via a hash reference, thereby establishing both order and integrity across the chain of blocks. These ideas were first implemented in the decentralized online transaction system named Bitcoin that is based on a particular distributed ledger (Nakamoto, 2008) named blockchain. The Bitcoin blockchain includes a full transaction history, including the allocation of all existing Bitcoins to specific cryptographic identities. Following the example of Bitcoin, various alternative systems were developed in the ensuing years that have expanded the potential applications beyond virtual asset transactions (Zhang and Lee, 2020). For example, by extending both the data structure and algorithms to support the execution of general- purpose code, blockchain systems such as Ethereum allow participants to store not only transaction code, but also general-purpose program code. Such code allows participants to predefine a set of operations to be executed under certain conditions. As this is particularly interesting for the (practical) automation of contractual exchanges, these programs are called smart contracts (Szabo, 1997), and they might have substantial implications for all kinds of e-commerce (Subramanian, 2018). These systems have no central authority by design, and the participants themselves add new entries to the shared data structure. Newly received entries that have not yet been included in the blockchain are forwarded to other participants and successively propagated through the system. However, the participants cannot simply add unconfirmed entries to their own copies of the blockchain, since they might not necessarily receive them in the same order as other network nodes and single participants may miss some entries. In order to keep all copies of the blockchain consistent, participants therefore need to achieve consensus on the state of the chain through a decentralized majority voting process. This process is especially complex in those blockchains where each participant can generate and use an unlimited number of cryptographic identities (e.g., in Bitcoin). If each of these cryptographic identities were entitled to one vote in the consensus-building process, malicious participants could easily compromise the majority vote and thus the system state by controlling most cryptographic identities. In order to avoid such manipulations, the voting weight of participants is based on other factors that are not arbitrarily scalable, unlike the number of cryptographic identities. Many blockchain systems therefore require participants who add new entries to the blockchain to expend an increasing amount of computing power (proof of work) or to stake value to commit to a vote (proof of stake). Other mechanisms exist, but are less frequently used at the time of writing (Baliga, 2017). Consensus mechanisms have several goals, the most important of which are (a) leadership selection and (b) rate limiting. The first ensures that the system fairly selects a primus inter pares tasked with briefly leading the network toward a new state that is accepted and shared by all (Gramoli, 2020). The second ensures that there is a limit to the rate at which new leaders are selected and consequently the rate at which the state of the blockchain changes. This not only slows down attacks, but also increases fairness between participants that might not be able to devote the same resources (Bohme et al., 2015; M¨ oser et al., 2013; M¨ oser and B¨ ohme, ¨ 2015). For example, in the Bitcoin system, the computation of a valid block requires a participant to not only validate the transactions to be included in the block, but also to repeatedly perform simple computational operations. Each new block is slightly modified by trial and error until it meets certain mathematical conditions. As participants only add validated

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blocks to their copies of the blockchain, the resulting chain represents the consensus of computing power in the system. It is therefore relatively robust against manipulation attempts because the computing power necessary to recalculate parts of the blockchain exponentially increases with each additional block. As an incentive to expend computing power, participants who add valid blocks to such a type of blockchain are rewarded with fresh virtual asset units (e.g., Bitcoin) and fees paid by those whose transactions were added to the blockchain (Nakamoto, 2008).

Blockchains can be classified into public vs. private as well as permissioned vs. permissionless chains. Combinations of these characteristics give rise to three different types of blockchain technology (Beck et al., 2018): (1) in public permissioned chains, all nodes can read transactions, but only authorized nodes can write them; (2) in public permissionless chains, all nodes are able to read, submit and write transactions; and (3) in private permissioned chains, only authorized nodes can read, submit and write transactions (Tsai et al., 2017). These distinctions have significant implications in terms of the design of the blockchain and the amount of trust required from the individual participants as well as the effort needed to prevent malicious attacks. In case the blockchain is used to support information exchange among companies along a supply chain where the participants know each other, permissioned and private chains that do not depend on energy-intensive consensus mechanisms might often be the preferred choice. In the context of e-commerce, different types of blockchain might apply simultaneously. For example, companies might deploy private and permissioned chains for their supply chains while allowing for payment via Bitcoin that is based on a public and permissionless chain. To incorporate this diversity, the research questions developed in the following sections operate on a rather high level of abstraction to include all different types of blockchain technologies. In case a specific technology is particularly affected, or differently affected, this is noted in the respective discussion and emphasized in the framework.

### A. Research Methodology

The methodology that implemented by this paper start with the process to collect and analysis current conventional commerce and e-commerce. Then identify the problem and chance for improvement. The results will be used to decide aim and objective. With objective decided we can derive the requirement that will be used as a parameter to find technology. The technology candidate implementation will be learned and then used as a foundation to propose architecture & system.

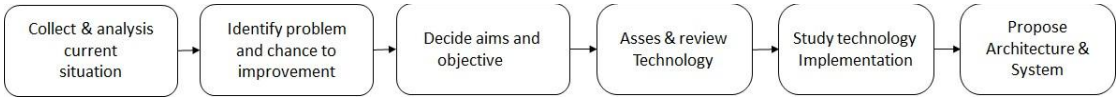


Figure 1. Online Transaction through Blockchain

### B. Discussion

As mentioned above, Blockchain has big potential to provide more secure, efficient, and transparent in many fields and offer an innovation that can create a new model, platform, and system for the better. Blockchain as e-commerce platform offers a new model and concept that solve the disadvantage of ecommerce. Although e-commerce has been growing, the offline transaction still exists, because of easier, more secure and direct transaction between buyers and sellers. In an offline transaction, P2P payment is already applied through the use of cash and it is the reasons that offline transaction more secure and easy. Beside Offline transaction, there is an online transaction. Online transaction is an indirect transaction that buyers and sellers do through media online. Buyers will pay the seller through 3rd party using the online method like transfer and virtual currencies. It is what e-commerce and fintech (finance technology) use, and it is involved them as the 3rd party.

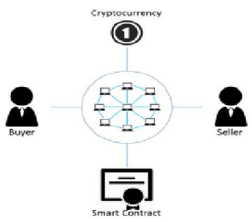


Figure 2. Online Transaction through

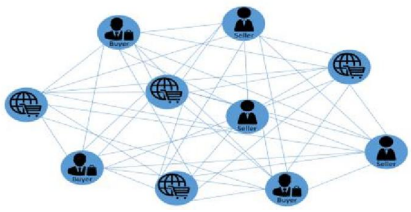

Figure 3. Distributed Ledger with Buyer, Seller, and E-commerce

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Solving the disadvantage of the online transaction which adopted by e-commerce and fintech, we propose (figure 2) online transaction through blockchain which will support P2P payments with Cryptocurrency [10]. Imagine if you can use digital payment directly like cash payment, that's what cryptocurrency try to achieve. Same with cryptocurrency, blockchain implementation also use a P2P network to validate transaction data and ledgers to store the data. We propose a ledger model (figure 3) that has e-commerce, sellers, and buyers as nodes, the model will give ownership of data to all parties involved so that no one is in control of data. With this ledgers model, the users are anonymous to reduce the misuse of data and also supports cryptocurrency as payment across e-commerce platforms involved. To ensure the security and enforce rule the smart contract will be used to seal the deal or transaction that happen.

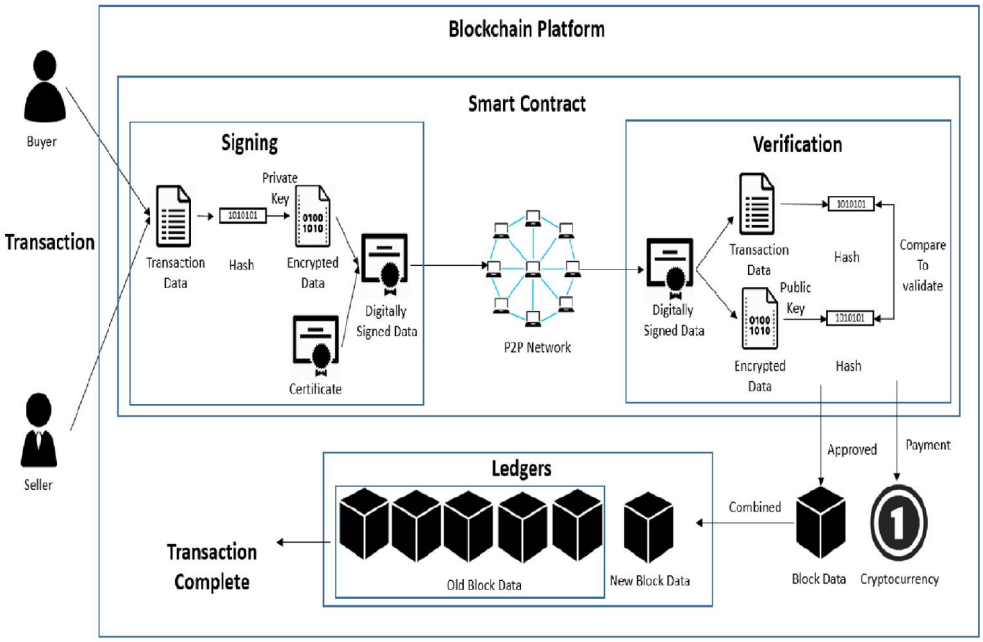


**Figure 4.** Blockchain as E-commerce Platform Architecture

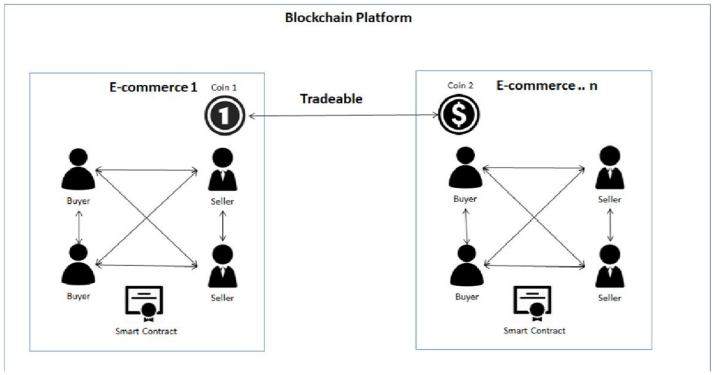


**Figure 5.** Blockchain as E-commerce Platform System

The process happens when buyers or sellers initiate the transaction. The data will be use hash function that will be encrypted using signer private key. The encrypted data will be signed (smart contract) then broadcasted to P2P network which consists of computers known as nodes that will validate the transactions. The nodes are consisting of a node that involved in a transaction. If we use the ledgers with anonymous users, then the users don't need permissions to participate on validation process. The verification process involves comparing signature from digitally signed data that will be decrypted using signer's public key. Once verified the transaction will be combined with other transaction to create a block of data. The block then will be added to existing blockchain or ledgers. Payment is done through cryptocurrency and transaction completed.

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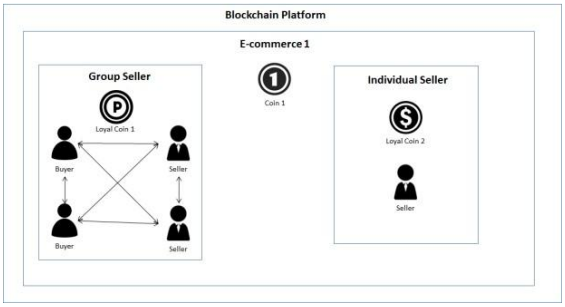


Figure 6. Blockchain as E-commerce Platform Loyalty System

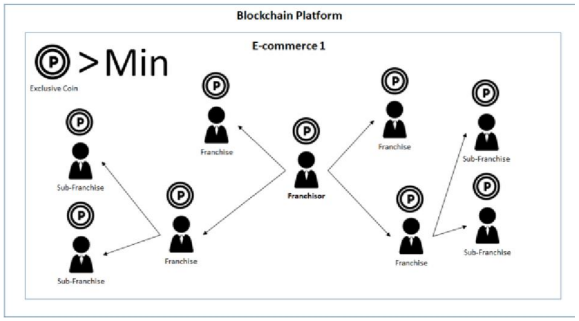


Figure 7. Blockchain as E-commerce Platform Franchising System

With the architecture (figure 4) as the base, we propose the blockchain platform that integrated much e-commerce into one system (figure 5). In this system, all e-commerce virtual currencies will be converted into cryptocurrency in the form of a coin that is tradeable with each other. Because crypto integration buyer or seller can exchange their e-commerce coin to others coins and then spend it easily. This system will support a direct interaction between all entities even buyer to buyer using a peer-to-peer approach. Peer-to-peer approach aim is to not involve 3rd party and cutting the commission fee. Without the 3rd party, the role to ensure enforce the rule goes to smart contract. The smart contract will automatically enforce the predetermined rule to all party involved. The smart contract also recreates the backend and inventory database. Without the 3rd party, the chance misuse data is gone while smart contract will secure the transaction. To complement the system, we propose the loyalty system. In this loyalty system, a group of a seller or individual seller can create the exclusive coin. Exclusive mean that this coin can only be used in their group and cannot be exchanged. Therefore, the coin will influence the buyer to do a transaction in the same shop. This coin can be gain from using the coin as mining reward and transaction reward. Using exclusive coin we also propose a franchising system. The Owner can become a franchisor when they create exclusive coin and set the minimum coin threshold for the franchise. If a buyer or seller can pass the minimum threshold then they can become a franchise and have the privilege to sell the product. And if they pas others set threshold then they have the privilege to create sub-franchise. Based on the research conducted, it can be seen that the blockchain implementation provides good benefits. Unfortunately, Indonesian regulations regarding cryptocurrency are not enough at all. The regulation still prohibits the use of cryptocurrency as a legitimate payment instrument. We analyze that even though it's possible some e-commerce will not join in using cryptocurrency because it can reduce their profit. If it can be implemented, it will create a decentralized e-commerce that secure, cannot be manipulated, cannot be misused, and free from interaction limitation.

## IV. LITERATURE SEARCH

To address the pending issues of blockchain in e-commerce as presented above, we conducted a narrative literature review. This approach is mainly used to describe and evaluate published articles without focusing on methodological details, and it fosters exploratory research by enabling the creation of a solid foundation for future investigation. Given the novelty of the subject, we preferred this approach over a systematic literature review (SLR), the latter of which is the method of choice when selection criteria as well as the methods of extraction and synthesis of the data are explicitly defined (Ferrari, 2015). We started our search process in academic databases, such as EBSCOhost Business Source Premier, Scopus and Google Scholar, but did not limit ourselves to academic peer-reviewed articles in the following phases of our research. Most notably, we found that in spite of getting numerous hits when using search terms such as "blockchain," "DLT" or "e-commerce" in full text searches, the number of relevant papers was drastically reduced when we filtered for articles that actually discuss the impact of the former two on the latter. The scope of our research also included the analysis of articles that investigate the topic of blockchain and e-commerce from different angles. We therefore screened the abstracts of all potentially relevant papers and created and selected several categories (Mayring, 2000), which finally led to the framework that we present in this paper. In line with the tenets of qualitative research, the final structure we discuss in the remainder of this paper emerged during the analysis and categorization process.

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## V. RESEARCH FRAMEWORK

Blockchain is a technological stack that impacts e-commerce via technological, legal, organizational and quality issues as well as consumer issues. It open up new opportunities by offering unprecedented technological possibilities, but at the same time, it necessitates a critical evaluation of current business processes, such as practices that involve sensitive customer data or the design of communication channels along the supply chain. Technological issues relate to the handling of data, privacy and security issues, development, implementation and the design of the underlying system as well as the potential impact of novel technologies, such as the Internet of Things (IoT), big data, cloud computing, artificial intelligence (AI) and machine-to-machine (M2M) communication. Legal issues are related to problems arising from the gathering, storage and analysis of data as well as potential security breaches and compliance requirements that pertain to regulations designated as "know your customer" (KYC) and "anti-money laundering" (AML). Additional issues concern the legal conformity of processes that are automated by the blockchain and of novel business structures, including fully decentralized autonomous organizations (DAOs) in the most extreme case. Blockchain also opens up new opportunities for access to capital markets that still operate in a legal grey area in many countries. While the fundraising side of this phenomenon has garnered most public attention and has led to an unsustainable bubble (Zetzsche et al., 2017), the fundraising aspects are only the first step as the underlying virtual assets sold during the fundraising process were almost always sold with a promise of usability and utility with the projects' internal e-commerce market system. This implies the potential emergence of multiple joint and disjoint virtual-asset-based e-commerce systems.

Organizational and quality issues include information, system and service quality as well as the traceability of data and payments, which relates to problems of data protection and security. Additionally, the structures within organizations might change leading to new business models as well as the need to reconfigure relations between organizations that might potentially impact the complete value network. Finally, consumer issues include the proliferation of cryptocurrencies, the integration of blockchain features into mobile applications, data-related aspects, with a special focus on security and privacy from a customer point of view, and topics that emerge from new opportunities for data use, such as the possibility to better target customers. Such developments imply relationships and customer service, but blockchain may also widen the digital divide. Each of the following sections has the same structure, briefly summarizing several elements of e-commerce followed by a discussion of four to six relevant research questions. Tables are shown that juxtapose important elements of e-commerce and potential blockchain-induced changes.

### 5.1. Technological Issues

The technological characteristics of blockchain are major drivers of innovation (Swan, 2015). However, it is presently unclear how to capitalize best on these properties to create business value as a substantial amount of uncertainty persists in regard to how to approach designing such systems. In the following sections, the extant e-commerce literature on these topics is briefly summarized and considered in the context of the opportunities and perils arising from blockchain. In the following sections, we discuss four important areas of e-commerce, namely, accessibility and traceability, privacy and security, novel technologies and system development and the corresponding blockchain-induced changes. In the following sections, we present each research question, followed by an in-depth discussion.

**Research Question T1:** How does blockchain impact accessibility and traceability in e-commerce?

Accessibility and traceability of data and payments have previously been identified as major success factors for e-commerce. Nederstigt et al. (2014, p. 296) point out that "E-commerce is one of the areas in which growing data congestion on the Web impedes data accessibility" and propose a framework that can create a semi-automatic ontology population of product information that can be found in web stores. Traceability is defined by ISO 9001:2000 as the ability to trace the history, application or location of an entity throughout its entire supply chain. In order to achieve traceability of data in general and payments in particular along the whole supply chain, sophisticated models have been proposed (Bechini et al., 2008). E-commerce transactions that are conducted via blockchain store purchase-related data in an ordered and immutable manner, which helps to improve data provenance and traceability—depending on the technical implementation of the blockchain system (Lo et al., 2017). Depending on the underlying virtual asset, the exchange might be denominated in a fiat currency, but settled through virtual assets priced market-to-market (Hardjono, 2020). Alternatively, the parties may agree to settle in virtual currencies or the virtual currency may itself be recognized as a

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government-sanctioned means of payment in which case it is either central bank-issued digital currency (CBDC) or e-money (i.e., so-called stable coins). In the European Union, electronic payments are regulated by the E-Money directive (European Parliament and Council, 2009). While both CBDC and e- money can be realized without an underlying blockchain technology, different forms of distributed ledgers are currently being tested to both better understand potential benefits and to get a better understanding of negative side effects (Baker, 2020).

Bahga and Madisetti (2016) and Nakamoto (2008) show how data provenance in combination with the immutability of blockchain can significantly contribute to the overall quality of available data, which in turn leads to better decisions based on that data. Furthermore, this can help to swiftly identify problems in case of food poisoning or to ensure fair remuneration along the supply chain (Bumblauskas et al., 2020; Garaus and Treiblmaier, 2021). Traceability is a central element of all types of blockchain, while accessibility can be restricted depending on the respective blockchain type as discussed above (Zheng et al., 2017).

**Research Question T2:** How does blockchain impact privacy and security in e-commerce?

Privacy and security are considered to be key features of e-commerce systems. The level of users' trust in web-based applications depends to a large extent on the security features in place (Aljukhadar et al., 2010). Fraudulent schemes that steal personal and confidential information (e. g., phishing websites) are detrimental to the overall success of e-commerce (Ramesh et al., 2017; Zhang et al., 2014). Alharbi et al. (2013) identify information technology systems, accountable business practices, physical design and networked infrastructure as the major antecedents of customers' perceived privacy and security concerns. A previously suggested solution to surmount privacy issues was privacy seals, but these have only been able to partly solve consumers' privacy issues (Moores and Dhillon, 2003). Transactions conducted on blockchains are, in case no privacy-enhancing technologies are used, available to all participants (L. Peng et al., 2020). In the case of public blockchains, transactions are linked to pseudonymous identities. If e- commerce is to be augmented with smart contracts, new security questions arise that pertain to (a) secure implementation, (b) fair execution, (c) secure exchange with other systems and (d) privacy (Halpin and Piekarska, 2017; Kethineni et al., 2018). Blockchain technology, implemented via consensus mechanisms, chained storage and sophisticated signature and verification systems, enables a multitude of new features. These include security features such as consistency, tamper-resistance, resistance to Distributed Denial of Service (DDoS) and double-spending attacks (R. Zhang et al., 2019) as well as the integration of privacy-preserving protection schemes in cases where sensor data is used (Chanson et al., 2019). However, blockchain technology also introduces novel risks, including, amongst others, miners taking over the infrastructure, loss or theft of private keys, double- spending attacks or flaws in smart contracts (Li et al., 2020).

**Research Question T3:** How does the combination of blockchain and novel technologies (e.g., IoT, data analytics, cloud computing, AI, M2M) impact e-commerce?

Several authors have highlighted the potential of incorporating novel ways of gathering and analyzing data into e-commerce applications, such as the integration of the Internet of Things (IoT), big data analytics, cloud computing, artificial intelligence (AI) and machine-to-machine (M2M) communication (Piotrowicz and Cuthbertson, 2014; Salah et al., 2019; Yu et al., 2017). In this context, IoT refers to the emerging network of physical objects (i.e., "things") that are embedded with networked sensors and components for the purpose of connecting and interfacing with other devices and systems (Khan and Salah, 2018). Related to the accompanying increase in available data, big data analytics is tasked with extracting value from increasing amounts of data (Russom, 2011). Finally, cloud computing denotes the on-demand availability of computer resources without active management by the user (Velte et al., 2009).

Peng et al. (2016) show how online robots that use an intention recognition model can be used to enhance e-commerce customer service, while Shang et al. (2012) illustrate how a three-layered (perception, network, service layer) IoT infrastructure can be applied to share relevant information. The combination of blockchain with innovative technologies has led to widespread speculation about novel use cases, ranging from combining the IoT with smart contracts in the insurance industry to enabling payments without cumbersome administrative processes (Underwood, 2016). In the field of healthcare, specifically when it comes to the analysis of radiological images and CT scans, Peterson et al. (2016) note that blockchain technology can generate mechanisms to compensate AI service providers for the development and

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execution of novel machine learning algorithms. Despite the huge potential that is recognized in this area, rigorous research on its implications for e-commerce remains scarce.

**Research Question T4:** How can e-commerce systems be developed and designed to capitalize on the technical characteristics of blockchain?

Specific guidelines have been published on how to develop and implement functional e-commerce architectures and system designs (Qin et al., 2009). For example, Peterson et al. (2016) develop a B2C implementation framework that follows the traditional phases of systems planning and selection, systems analysis, systems design and systems implementation and operation, and they also specify various sub- phases. Eliciting and modeling requirements for e-commerce solutions has been a major challenge for system engineers and developers. Hsia et al. (2008) present a goal-driven methodology for identifying B2C application requirements that identifies core services, develops a use case model, evaluates the goals and integrates alternatives and trade- offs. Asher (2007) examines four electronic data interchange projects and develops a B2B e-commerce framework that provides guidelines for the type of partnership to be pursued. However, with the growing adoption of both general-purpose and specialized blockchains, it will become increasingly challenging for e-commerce businesses to select appropriate platforms and ensure cross-technological compatibility. As Porru et al (2017) and Sillaber et al. (2020) point out, new use cases require further consideration of the resource requirements for blockchains and new processes and design patterns as well as the development of blockchain-specific implementation frameworks.

With the emergence of standardized programmable interfaces for smart contracts (e.g., “ERC” in Ethereum), businesses have to increasingly adopt standardized programmable interfaces and data exchange formats (Norvill et al., 2019).

Design-oriented research must therefore carefully document the purpose of the respective system as well as the features of the underlying blockchain and the rationale for using blockchain instead of a traditional database solution. In other words, the characteristics of blockchain, such as data

### 5.2 Limitations and Further Research

The findings of this research are limited by the novelty of the domain and a dearth of literature specifically dealing with blockchain and e- commerce. Besides, the ongoing development of blockchain-based technologies and the media attention given to cryptocurrencies in combination with the globally evolving legal situation makes it hard to predict what the technology will actually be capable of delivering in a couple of years and what legal frameworks will be applicable in different countries. The research questions presented in this paper are therefore not bound to a specific blockchain implementation, legal framework or business model. Instead, they are expressed as generally applicable considerations that necessitate further refinement to focus on clearly defined sub-problems of importance in each respective context. In line with the tenets of narrative reviews, our focus was not on the reproducibility of the results, but rather on the identification of novel research areas. Further research therefore needs to consider the dynamics of the domain, which to some extent was also a characteristic of e-commerce, especially in its early years. Additionally, future studies can identify suitable theories that might provide further insights and use empirical data to investigate the topics developed in this paper. Systematic reviews of the literature might help to extend and refine our framework as soon as enough academic literature has been published on the subject. Considering predictions of a major impact by blockchain on society and the economy, an objective and critical evaluation by academic researchers can help to structure the domain and identify those characteristics of blockchain that contribute value to e-commerce success. A solid foundation of academic literature might provide the basis for inductive research with the goal of generating new theory that will enable subsequent deductive research with the goal of testing these theories as well as individual hypotheses.

Within only a couple of years, blockchain has transformed from an obscure technology known only to a handful of dedicated cryptographers and specialized computer scientists into a mainstream topic that attracts billion-dollar investments and interests researchers from a wide variety of academic fields, including computer science, information systems, mathematics (especially game theory), economics, business administration and even sustainability. Since this development has occurred within a relatively short time frame and the technology is still under development, a lot of uncertainty exists regarding the future development of blockchain and related technologies and their potential impact on the economy and society. In contrast, research surrounding e- commerce as a business model has developed over several

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years, and academic researchers have systematically structured the domain and identified the most crucial success factors. This paper illustrates how an assessment of the potential impact of blockchain on e-commerce can build on previous research and shows how relevant research questions can be derived. It extends previous research frameworks in this area by providing an explicit focus on how to investigate blockchain-related issues in e-commerce. It is suggested that the domain be split up into four areas: (a) technological issues, (b) legal issues, (c) organizational and quality issues and (d) consumer issues. The current literature on e- commerce success was researched in order to identify relevant antecedents for success across these four areas, and these antecedents were considered in the light of the characteristics and proposed impact of blockchain. This process led to the derivation of 19 research questions that can be used for a structured and thorough investigation of the impact of blockchain on e-commerce.

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