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Blockchain for Managers

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Introduction

Blockchain has become known as a type of distributed ledger technology that helps to lower transaction costs and make intellectual property ownership and the transfer of financial assets more transparent. Previous ledger systems involved a centralized form of record keeping and a traditional database controlled by a trusted intermediary who verified transactions. The distributed nature of blockchain technology allows for more direct peer-to-peer transaction processing within a network where every participant has the same access rights and where there is transparency about the location and transfer of assets. This fundamental change in the model of the exchange and governance of interactions between economic participants has been heralded as a new enabler for both start-ups and incumbents to create new business and operating models.[1]

Their advocates believe that blockchains may eventually reshape business and society just like the Internet did in the past. While the Internet facilitated the better transmission of data and information around the globe, blockchains hold out the promise of better facilitating transactions and the exchange of value. For this reason, blockchain has been referred to as "the Internet of Value."[2] Just like with the rise of the Internet—people may remember the dot-com bubble and the subsequent long-term recovery and rise of the GAFA companies (Google, Amazon, Facebook and Apple)—cryptocurrency markets have experienced a steep rise and fall within a short time period (2017–18).[3] The exchange of cryptocurrencies such as Bitcoin through blockchain is of course just one use in a plethora of potential uses of this new general-purpose technology and it is difficult, if not impossible, to predict further ups and downs in the near future.

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[1] Teppo Felin and Karim Lakhani, "What Problems Will You Solve With Blockchain?" *MIT Sloan Management Review* 60, no. 1 (Fall 2018): 32–38.

[2] Pierre Noizat, "Welcome to the Internet of Value!" Medium, February 15, 2018, https://medium.com/blockchainio/internet-of-value-fa32a8f0ed39.

[3] Kane Pepi, "Bitcoin vs The Dot Com Bubble: Are the Comparisons Necessarily a Bad Thing?" Blockonomi, November 26, 2018, https://blockonomi.com/bitcoin-vs-the-dot-com-bubble/.

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The purpose of this technical note is to introduce managers to blockchain. What does every manager need to know about blockchain? Under which conditions does it make sense to use this technology? And what are the organizational and governance challenges that require managers' attention?

Traditional Centralized Systems

In a traditional setting, every organization has its own ledger—a book or file recording the history of all economic transactions. To verify and facilitate transactions between individuals and organizations and thereby change the ledger of each party, trusted third parties such as banks, certificate authorities and credit-card companies are typically involved. This helps mitigate counterparty risks and ensures that each party fulfills its contractual obligations. Past experience with traditional centralized systems highlights the following limitations:[4]

- Multiple versions of the truth. All the parties—the trading partners and the trusted third parties upon which they rely—maintain their own electronic records (i.e., digital ledgers) to record transactions and these centralized records are not necessarily in sync.
- Little transparency. Each party maintains its own ledger. As a result, parties to an exchange do not have access to the status of transactions as recorded in the ledgers of other parties, the fees being charged, which institution exerts control, and so forth.
- Slow settlement times. Trading parties spend a lot of time and money reconciling and settling transactions to make sure records are synced. Some transactions, such as cross-border payments and trade finance, can take days or weeks to settle.
- High transaction costs. Fees often accumulate with each step in the process. Transaction costs are high because the parties need to monitor each other's activities to prevent opportunist behavior and to ensure agreements are executed as promised. There are also additional costs associated with compliance reporting.
- Security and privacy. Trading systems often process private and highly sensitive data that require a high degree of protection against attacks. However, there are many known examples of high-profile attacks on traditional centralized systems, including the famous security breach at Equifax in 2017.

Through its distributed design and the use of advanced cryptography, blockchain promises to deal with many of the limitations of traditional centralized systems highlighted above. Before we look at what blockchain actually is, how it works and how managers can benefit from it, consider the following brief history of blockchain.

History of and Introduction to Blockchain

Blockchain became widely known with the introduction of Bitcoin. In the white paper "Bitcoin: A Peer-to-Peer Electronic Cash system," published in 2008, Satoshi Nakamoto (a pseudonym) proposed Bitcoin for more efficient and direct electronic payments.[5] In 2009, Nakamoto released the Bitcoin open-source software, making it possible for anyone to download and use

[4] Mary C. Lacity, A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How (Stratford-upon-Avon, England: SB Publishing, 2018).

[5] Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," Bitcoin.org, 2008, https://bitcoin.org/bitcoin.pdf.

it to develop new tools. Bitcoin uses first-generation blockchain, whose sole purpose is to support cryptocurrencies. The second generation of blockchain, launched in 2013, moved away from Bitcoin and its sole focus on cryptocurrencies. It allows for all kinds of transactions to be coded into a blockchain. By extending its functionality, this created a more general-purpose programmable platform that enables business innovation across sectors.[6]

A blockchain allows untrusting parties with common interests to cocreate a permanent, unchangeable and transparent record of exchange and processing without relying on a central authority.[7] Blockchain applications use computer algorithms to confirm asset authenticity, authenticate asset ownership and validate transactions. Blockchain offers a digital peer-to-peer transaction system where an exact copy of the same digital ledger is stored and updated across a network of users, referred to as *nodes*. The database consists of chains of *blocks*, each containing a list of transactions. Computer algorithms sequence transactions and time-stamp and permanently store them on the shared distributed ledger. Transactions on the shared ledger are immutable. All parties can be confident they are dealing with the same data. To validate the transactions within the block, an advanced cryptographic puzzle has to be solved by so-called *miners*. This action is also referred to as *proof of work*, on which miners compete as they seek to validate blocks and get *rewards* (such as Bitcoins). When the puzzle for a block of transactions is solved, a new block for new transactions is added to the *blockchain*. Each block is added in chronological order to the blockchain, which thus contains the complete history of all transactions. The technology's cryptographic design makes it practically impossible to reverse or tamper with transactions. In theory, the only way to break a blockchain application is to commandeer more than 50% of the nodes before any of the other nodes notices.

In short, "a blockchain application is a distributed, peer-to-peer system for validating, time-stamping, and permanently storing transactions on a distributed ledger that uses cryptography to authenticate digital asset ownership and asset authenticity, and consensus algorithms to add validated transactions to the ledger and to ensure the ongoing integrity of the ledger's complete history."[8] Five basic principles underlie blockchain technology:[9]

- *Distributed database*. Each party on a blockchain has access to the entire database and its complete history, with no single party controlling the data or the information. Records in the database can be verified directly by each party, without an intermediary.

- *Peer-to-peer transmission*. Communication occurs directly between peers rather than going through a central node. Each node stores the same information, and any changes to information in one node are broadcast to the entire network of nodes.

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[6] Don Tapscott and Alex Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World (New York: Portfolio/Penguin, 2016).

[7] Catherine Mulligan, "Blockchain & Digital Transformation" (presentation, Centre for Cryptocurrency Research and Engineering, Imperial College London, 2016), https://www.imperial.ac.uk/media/imperial-college/research-and-innovation/thinkspace/public/1000_Catherine-Mulligan.pdf.

[8] Mary C. Lacity, *A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How* (Stratford-upon-Avon, England: SB Publishing, 2018). A consensus algorithm is the process in computer science used to achieve agreement on a single data value among distributed processes or systems.

[9] Marco Iansiti and Karim R. Lakhani, "The Truth About Blockchain," *Harvard Business Review* (January-February 2017), https://hbr.org/2017/01/the-truth-about-blockchain.

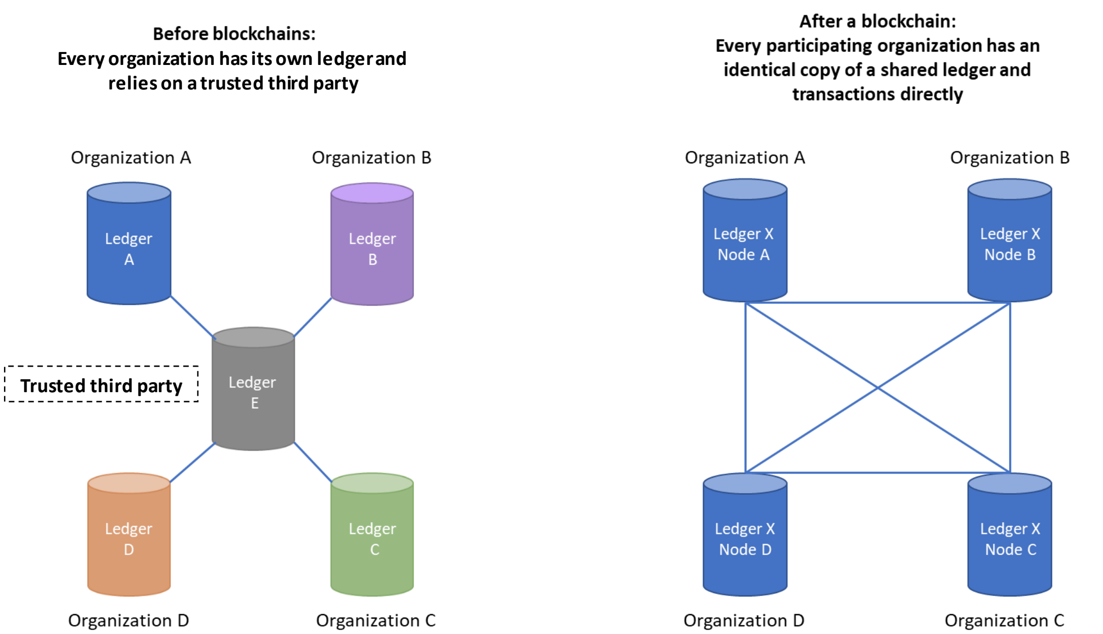
- *Transparency with pseudonymity*. Every transaction and the values associated with transferred assets are visible to anyone participating in the system. Each node—that is, every user and participant in the network—has a unique 30-plus-character alphanumeric address that identifies it. These addresses are the basis for processing transactions and users may choose to remain anonymous.

- *Irreversibility of records*. Information about transactions cannot be altered once entered as these records become part of the chain. Computational algorithms and approaches are used to ensure that the database records are permanent, chronologically ordered, and available to all nodes/users in the network.

- *Computational logic*. Blockchain transactions are processed using computational logic. Algorithms and rules can be created and deployed to trigger transactions between nodes automatically.

Figure 1 shows a simplified overview of centralized versus decentralized transaction systems.

Figure 1
Before and After Blockchain: A Simplified Overview



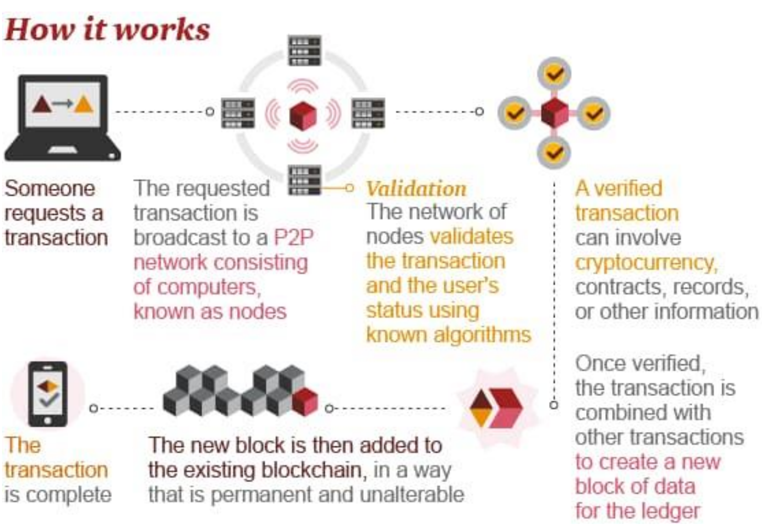
Source: Mary C. Lacity, *A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How* (Stratford-upon-Avon, England: SB Publishing, 2018).

A large number and variety of real-world blockchain use cases already exist across different industries and sectors. In banking, the R3 consortium of global financial institutions has attracted significant attention with its efforts to create an open-source distributed ledger platform called Corda.[10] The following are just a few of the many other examples of blockchain application:

- Telegram is developing a blockchain-based platform called the Telegram Open Network (TON) to extend its messaging app to services such as payments, file storage, and censorship-proof browsing.
- Numerai, backed by First Round Capital and Union Square Ventures, is decentralizing the traditional hedge-fund model using a rules-based meta-model for making trades.
- Follow My Vote is building an open-source and secure online voting platform to create greater transparency in the process of casting, tracking, and counting votes, and to eradicate voter fraud.[11]

Figure 2 provides a schematic overview of how blockchain works.

Figure 2
Blockchain: How It Works



Source: "Making Sense of Bitcoin, Cryptocurrency and Blockchain," PwC United States, 2018, https://www.pwc.com/us/en/industries/financial-services/fintech/bitcoin-blockchain-cryptocurrency.html.

[10] Wikipedia, s.v. "R3 (Company)," last modified March 14, 2019, 12:28 (UTC), https://en.wikipedia.org/wiki/R3_(company).

[11] "Banking Is Only the Beginning: 50 Big Industries Blockchain Could Transform," CB Insights, December 19, 2018, https://www.cbinsights.com/research/industries-disrupted-blockchain/.

The Multilayered Architecture of Blockchain

Digital technology in general is based on the multilayered architecture model. In the case of the Internet, distinctions are typically made between the following layers:

- Physical layer (the actual medium that transports the digital data, such as optical fibers or a wireless spectrum)
- Network layer (where the routing of packets between different physical routers is managed, most commonly through IP addresses)
- Transport layer (where the raw connection state is managed, most commonly through the transmission control protocol or TCP)
- Session layer (management of the higher-level connection state, such as HTTP)
- Application layer (where the actual applications are seen working, such as in a Google search)

In the case of blockchain, distinctions can be made between the following layers:[12]

- *Physical hardware layer*. This is the actual hardware, including local servers or cloud computing resources, used for mining and validating data and storing the data in the blockchain.
- *Network layer*. This is where the data packets are passed between the different nodes.
- *Consensus layer*. As its name implies, this is a protocol that makes sure all the nodes in a blockchain network agree—that is, that nodes are using exactly the same copy of the digital ledger. This protocol describes the format of a ledger that is publicly visible and a consensus function that network participants use to determine which of multiple candidate ledgers is the consensus ledger. The protocol is also a mechanism for adding new blocks to the ledger. Security mechanisms are implemented on the consensus layer, which involves implementing a consensus function that cannot be fooled.
- *Mining layer*. This protocol incentivizes parties to maintain the consensus and add blocks to the ledger by performing proof of work. The primary challenge is to provide participants in the network with enough of an incentive to confirm new blocks continually to achieve liveness. Mining involves hashing a potential block and checking to see whether the hash fits with the current difficulty rules.
- *Propagation layer*. This protocol determines how the ledger and blocks are transmitted between nodes in the network. Nodes should be able to disseminate confirmed blocks to other nodes quickly, and the protocol must ensure stability.
- *Semantic layer*. This is a specification of how new blocks must relate to previous blocks and a protocol for verifying conformity with the specification. This is important for achieving correctness. Each block has a meaning (such as sending currency between parties) and that meaning must be confirmed correctly through a semantic specification.

[12] David Xiao, "The Four Layers of the Blockchain," Medium, June 21, 2016, https://medium.com/@coriacetic/the-four-layers-of-the-blockchain-dc1376efa10f.

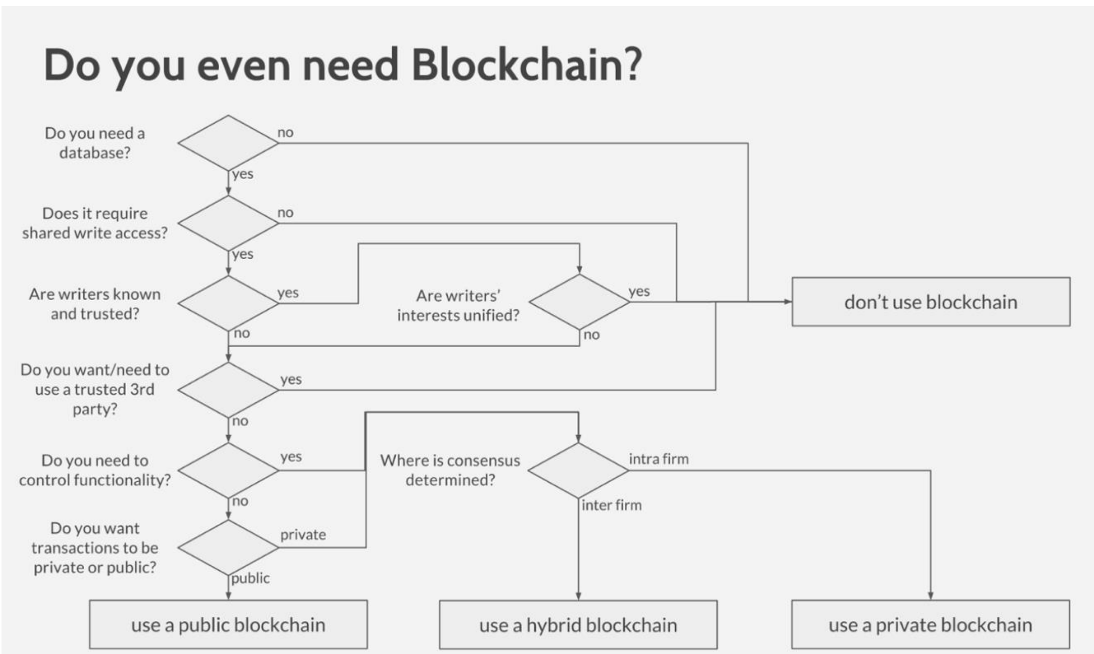
- *Application layer*. This is an application code that implements a particular desired functionality, addressing specific user needs.

The consensus, mining, propagation and semantic layers make up the blockchain as it is most commonly understood. Applications and application programming interfaces (APIs) connecting with each other are built on top of those four layers of the blockchain.

Choosing a Type of Distributed Ledger Technology

Before you choose a type of distributed ledger technology, first decide whether you even need blockchain or not. (See **Figure 3**.)

Figure 3
Do You Need Blockchain?



Source: Bart Suichies, "Why Blockchain Must Die in 2016," Medium, December 21, 2015, https://medium.com/@bsuichies/why-blockchain-must-die-in-2016-e992774c03b4.

Blockchain is sometimes called the "trust protocol." In this context, the word "trust" is defined as trust that the records on the distributed ledger agree across copies and it has nothing to do with faith or confidence that trading partners are benevolent or will play by the rules. The definition "trust that the records on the distributed ledger agree across copies" equates to "trust that the computer algorithms will reject faulty transactions, ignore faulty nodes on the network, and never modify the valid transaction once they have been added to a ledger." For a given blockchain application, protocols serve as a blueprint to ensure the correctness and ongoing integrity of records. In general, blockchain protocols can be divided into permissionless and permissioned protocols.

In the first case, a blockchain network can be characterized as *permissionless* when access to it is not restricted. For this reason, such networks are also referred to as *public* blockchains.

Anyone with the access to the Internet can join and start verifying the exchange of values and information and see all the transactions that have taken place over time. This type of blockchain was the original concept as outlined by Satoshi Nakamoto. The most widely used examples are the Bitcoin, Ethereum and Stellar blockchains (cryptocurrency networks). While it is almost impossible to infer the identity of a network member, anyone can submit transactions to the blockchain provided they obtain some of the native digital assets (such as cryptocurrency). For the Bitcoin, Ethereum and Stellar blockchain applications, people can buy their native digital assets—bitcoins, ethers or lumens from exchanges such as Coinbase (US-based), Kraken (US-based), Bittrex (US-based), Bitfinex (Hong Kong-based), Bitstamp (Luxembourg-based), CEX.IO (British-based), Coinmama (Virgin Islands-based) and Binance (China-based). Additionally, anyone can buy the necessary hardware, download the entire Bitcoin and Ethereum codebase, become a miner, and compete for block rewards paid in bitcoins or ether currency. All transactions can be observed on the following websites:

- Bitcoin (BTC) at BlockExplorer, https://blockexplorer.com/
- Ether (ETH) at Etherscan, https://etherscan.io/
- Stellar lumens (XLM) at StellarChain.io, https://stellarchain.io/

In the second category of blockchain protocol, a blockchain network is called *permissioned* or *private* when the network owner decides who can join the network and only selected members of the network are given the rights to verify blocks. The network owner may also decide on a consensus mechanism and rule for the verification of blocks. Private blockchains are aimed at business users, where participants in the network basically know with whom they are doing business even if participants may hide their identity. Permissioned blockchains rely on a front-end gatekeeper to enforce rights of access. (See **Figure 4**.) The gatekeeper is like a security guard who checks a badge before allowing entry. The gatekeeping function may be governed collaboratively by the trading partners or by a single enterprise, such as a regulatory authority that issues licenses to take part. Once the participants are past the gatekeeping function, they enter the distributed blockchain application.[13]

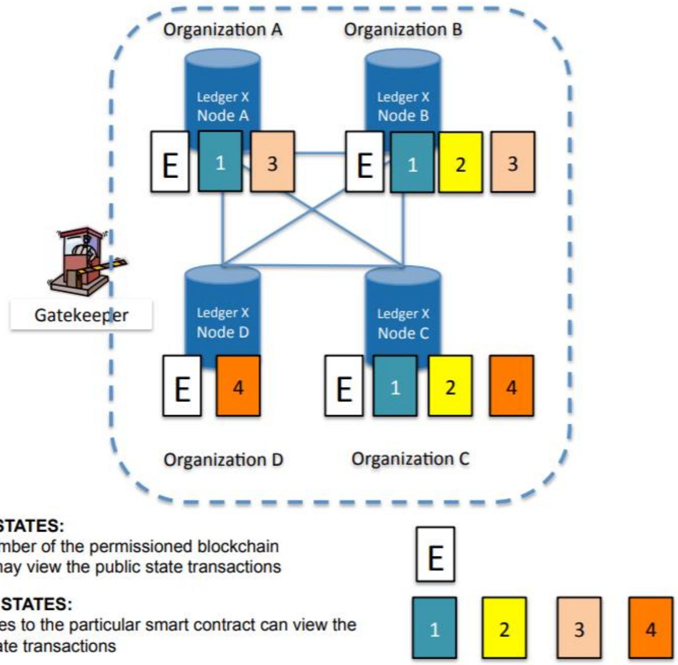
The Linux Foundation's Hyperledger Fabric is an example of a private, permissioned blockchain. It has become the de facto standard for enterprise blockchain platforms and is used widely—for example, in banks. Hyperledger Fabric uses smart contracts (explained below), called chaincode, to create separate channels, which can be thought of as multiple miniature ledgers within a blockchain network. A given node in a Hyperledger Fabric blockchain network has access only to the channels that it created or in which it was invited to participate.[14]

[13] Mary C. Lacity, A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How (Stratford-upon-Avon, England: SB Publishing, 2018).

[14] Mary C. Lacity, A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How (Stratford-upon-Avon, England: SB Publishing, 2018).

Figure 4

A Permissioned Blockchain Restricts Access and Nuances Read/Write Access Using Smart Contracts



Note: Organization A is party to smart contracts 1 and 3 but cannot observe smart contracts 2 and 4. Organization B is party to smart contracts 1, 2 and 3 but cannot observe smart contract 4. Organization C is party to smart contracts 1, 2 and 4 but cannot observe smart contract 3. Organization D is party to smart contract 4 but cannot observe smart contracts 1, 2 and 3.

Source: Mary C. Lacity, *A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How* (Stratford-upon-Avon, England: SB Publishing, 2018).

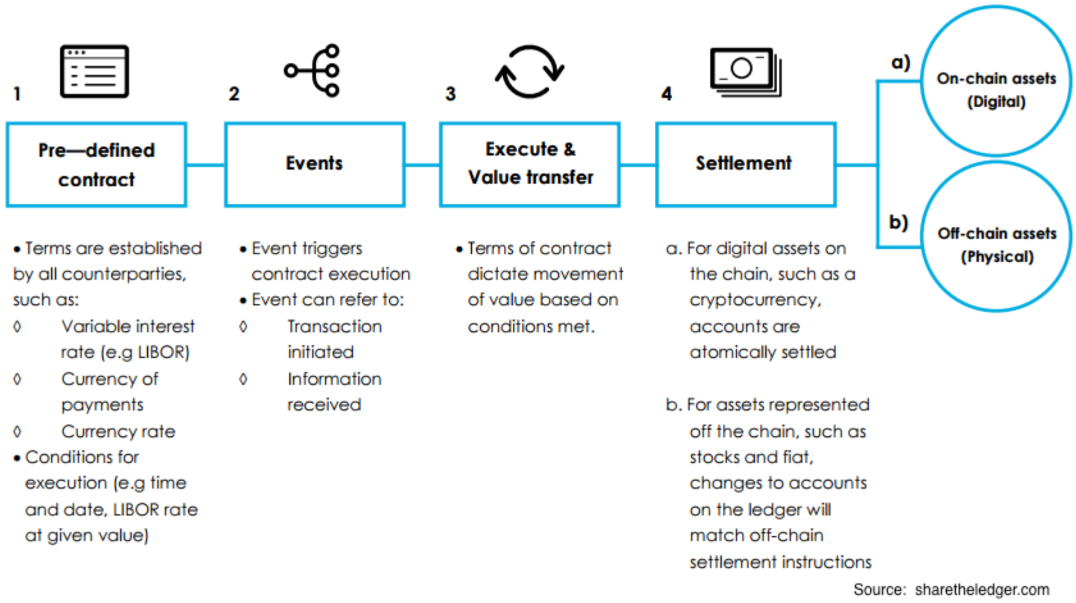
Smart Contracts

A blockchain provides a basic infrastructure for the exchange of value. Functionality may be added on top of that infrastructure. A smart contract is a type of functionality that can be added to a blockchain. It is a computer program containing a set of rules whereby the parties of the contract agree to interact with each other and, when these predefined rules are met, the agreement is enforced automatically. A smart contract is a form of decentralized automation.[15]

Figure 5 provides an overview of how a smart contract works.

[15] "Smart Contracts," BlockchainHub, https://blockchainhub.net/smart-contracts/.

Figure 5
Functioning of a Smart Contract



Source: Figure from The Shared Ledger (https://sharetheledger.com/), used in "Smart Contracts," BlockchainHub, https://blockchainhub.net/smart-contracts/.

Use cases of smart contracts abound: lotteries, voting, crowdsourcing, asset sharing (such as Uber, Airbnb and Spotify), asset tracking, identity management, bidding, rating, gaming and gambling.[16]

One example of smart contract use is renting a car. HireGo is a blockchain-based peer-to-peer car-hire platform and marketplace that provides a range of cars for hire in a trustless and secure way. Users are able to select a vehicle from a directory of available cars, make a reservation and settle the payment via a cryptographic token. Bitcoin and ether are the most well-known blockchain tokens used for payment but HireGo launched a new token called Hgo, which is used as the currency for payments in the app. Vehicles in the HireGo marketplace are crowdsourced from platform users, some of whom are classed as "power users" because they make larger numbers of vehicles available on the platform. HireGo automates the transactions in its marketplace through smart contracts, which are used for initializing the car contract, renting the car, returning the car, distributing the earnings, and so forth.

Challenges

There are a number of known challenges when implementing blockchain solutions. One challenge is *scalability*, along with the discovered limits to the number of transactions a blockchain network can process. As more and more transactions and blocks pile up on a blockchain, the on-chain transaction processing requirements increase as every block carries the history of the blocks before it in the chain. What complicates things further is that the block size is typically limited. In the case of the Bitcoin blockchain network, blocks were originally hard-

[16] Mary C. Lacity, *A Manager's Guide to Blockchains for Business: From Knowing What to Knowing How* (Stratford-upon-Avon, England: SB Publishing, 2018).

capped at 1 MB, or around 2,020 transactions. These limits have been increased but blocks continue to grow further, then they reach their limits, and they require more time to be processed. Limits to processing capacities are also determined by the time-consuming peer-to-peer verification mechanism and the limitations of the underlying computing infrastructure. Finally, another aspect of limited scalability is the environmental impact in terms of energy consumption.[17]

Another challenge for incumbent firms adopting blockchain technology is *integration*. Imagine a large telecommunications firm is already using enterprise resource planning (ERP), customer relationship management (CRM) and other enterprise solutions for processing transactions. Adopting a shared blockchain solution within the firm's ecosystem and network of firms will require integration between the old IT systems landscape and the new shared and open infrastructure. Different systems will likely be using different formats and models for storing and sharing data. Rearchitecting the legacy systems to fit the blockchain system will be time-consuming and require a lot of financial investment. Adapting a shared blockchain solution to the proprietary requirements of a single participant in the network, on the other hand, may lead to a solution that does not leverage the new technology's potential.[18]

A primary challenge of implementing blockchain, given its shared and distributed architecture, is *governance*. From a purely technical standpoint, blockchain has great potential for achieving greater efficiency and more transparent coordination within supply chains that involve networks of interconnected firms. For example, the Danish shipping giant Maersk and IBM announced a joint venture in 2018 to create a real-time distributed ledger for more transparent and efficient transaction processing in global shipping. To realize the potentials of blockchain in such a scenario, however, different firms must agree on standards, rules, and a shared platform for automated governance.[19]

A challenge for public blockchains such as Bitcoin is dealing with *ethical issues*. The advent of cryptocurrencies has fueled the shadowy and often illegal dealings of the black market and the dark web. Criminals reportedly use cryptocurrencies to sell and buy forbidden goods on online marketplaces, often under the radar of the public and authorities. An example was Silk Road, an anonymous, international online marketplace that operated as a Tor hidden service and used bitcoins as exchange currency. Cryptocurrencies are reportedly also used for money laundering and to process payments when criminals use ransomware to extort money. Finally, with the second generation of blockchain, criminals can also leverage smart contracts to carry out malicious activities.[20]

Despite the proclaimed benefit of enhanced *security* that blockchain technology offers, its *51% vulnerability* is often mentioned as an indicator that even a blockchain can be attacked. Remember that mutual trust on a blockchain is established through the distributed consensus mechanism. The threshold for reaching consensus is "at least 50%". Imagine a scenario where a

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[17] BitRewards, "Blockchain Scalability: The Issues, and Proposed Solutions," Medium, April 25, 2018, https://medium.com/@bitrewards/blockchain-scalability-the-issues-and-proposed-solutions-2ec2c7ac98f0.

[18] Prince Kumar, "Blockchain: What Are the Implementation Challenges?" IDG Connect, March 22, 2018, https://www.idgconnect.com/idgconnect/opinion/1019595/blockchain-implementation-challenges.

[19] Teppo Felin and Karim Lakhani, "What Problems Will You Solve With Blockchain?" *MIT Sloan Management Review* 60, no. 1 (Fall 2018): 32–38.

[20] Alexander Lielacher, "7 Challenges That Need to Be Addressed Before Blockchain Mass Adoption Is Possible," ICO Alert, April 2, 2018, https://blog.icoalert.com/7-challenges-that-need-to-be-addressed-before-blockchain-mass-adoption-is-possible.

large group of attackers exploits this consensus mechanism by jointly reaching more than 50% of controlled nodes on the network, allowing them to manipulate and modify the blockchain information. This would allow them to carry out attacks such as reversing transactions and initiating double spending, excluding and modifying the order of transactions on the chain, hampering normal mining operations, or impeding the confirmation operation of normal transactions. Another security risk is the potential loss of a user's private key, which in a blockchain system is generated and maintained by the user instead of third-party agencies. The private key may get into the hands of a criminal and then used to tamper with the blockchain.[21]

Finally, public blockchain systems in particular may involve challenges when attempting to maintain *privacy*. Remember that transactions processed and stored on a blockchain are visible to anyone participating in the system. In some contexts, this may actually be a key feature. In most cases, however, when blockchain is used in traditional business scenarios, maintaining the privacy of participants in a value network is critical. One example is storing private patient data on a blockchain as is done in Estonia. In this way, certain distributed ledgers involve the processing of proprietary data, government data, and other types of data with stringent requirements to protect privacy. In such cases, a private blockchain solution may still be an option.[22]

Recommendations

To tackle some of the challenges involved in implementing blockchain systems, managers are advised to approach blockchain innovation differently.

First, blockchain innovation requires an *open collaboration mindset*. Blockchain is a technology that is applied beyond the firm's boundaries. In the past, firms viewed technology primarily as an internal asset that they would invest in, control, and manage internally. Blockchain is a prime example for the new reality where technology embeds itself into the firm's external environment, becomes distributed, and requires a more open and shared management approach. Opting for blockchain technology is a highly collaborative endeavor. It requires complex coordination among multiple stakeholders in the firm's value ecosystem. Both private and public-sector entities will be involved in implementing a new blockchain system in the firm's industry. This is necessary to reach agreement on new legislation, new technical standards, and a revised set of processes and about how to do business as a network of firms and other actors. A prime example of the need for an open collaboration mindset is logistics. The firm DHL is exploring the use of blockchain technology through collaboration with all kinds of entities in its ecosystem, seeking to jointly create more value for each participating organization.[23]

Second, blockchain technology is still a relatively novel technology with lots of potential but also high risks of failure—*start small!* As with any new technology, it is advisable to start by reimagining the firm's (and ecosystem's) strategy by developing the vision of how blockchain might affect the dominant business model in the industry and how key business challenges can be met better through the use of the new technology. Opportunities and threats should be

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[21] Xiaoqi Li, Peng Jiang, Ting Chen, Xiapu Luo, and Qiaoyan Wen, "A Survey on the Security of Blockchain Systems," arXiv, March 6, 2018, https://arxiv.org/pdf/1802.06993v2.pdf.

[22] Alexander Lielacher, "7 Challenges That Need to Be Addressed Before Blockchain Mass Adoption Is Possible," ICO Alert, April 2, 2018, https://blog.icoalert.com/7-challenges-that-need-to-be-addressed-before-blockchain-mass-adoption-is-possible.

[23] *Blockchain in Logistics* (Troisdorf, Germany: DHL Customer Solutions and Innovation, 2018) https://www.logistics.dhl/content/dam/dhl/global/core/documents/pdf/glo-core-blockchain-trend-report.pdf.

carefully weighed up against each other. After defining the specific scope of a prototypical implementation of blockchain, develop a proof of concept with the primary goal of learning. It is only by learning through such prototyping and testing that specific and realistic use cases for the full implementation of blockchain technology will be identified. Finally, scaling a blockchain system and governing it carefully are recommended in order to achieve widespread acceptance within the firm's ecosystem of participating actors. An example of starting small being followed as an approach is Deutsche Bank. To pursue blockchain opportunities, the bank focused on reimagining its global transaction banking business from a strategic perspective. Through a stepwise approach, the bank tested the smart contract's self-executing potential for reinventing the entire corporate bond life cycle.[24]

Third, firms thinking about a blockchain initiative should prepare their internal governance and organizational capabilities by transitioning to *platform-based governance*. Traditional organizational governance for technology use relies on functional structural arrangements (such as centralizing some technology decision-making rights while decentralizing others), formal processes for how business and IT stakeholders work together internally, and relational mechanisms for achieving internal organizational alignment. Platform-based governance, in contrast, involves the definition and use of standards for the common platform, and relies on automated processes embedded through rules into the platform architecture. It divvies up responsibilities according to the multiple different layers of the platform architecture that supports coordination and exchange across firms' boundaries. In recent years, large banks have been transforming their internal governance toward platform-based governance as a means of facilitating ecosystem partnering, software innovation, and greater industrialization. Platform-based governance allows for scalable distributed innovation and cooperation, and its reliance on standardized rules and automated processes fits well with blockchain technology.[25]

Conclusion

Blockchain has the potential to disrupt many industries. Managers should explore this potential while considering the risks and specific nature of distributed innovation and networked business that blockchain adoption entails. A key ingredient of success in a blockchain-based business world is preparing the organization in terms of its culture, technology systems, structure, and skills to compete using a networked approach. Success in adopting and implementing blockchain may require a greater organizational transformation, which should be the top priority of the entire executive team.

[24] Lynda M. Applegate, Roman Beck, and Christoph Müller-Bloch, "Deutsche Bank: Pursuing Blockchain Opportunities (A)," HBS No. 817-100 (Boston, MA: Harvard Business School Publishing, April 2017).

[25] Robert Wayne Gregory, Evgeny Kaganer, Ola Henfridsson, and Thierry Jean Ruch, "IT Consumerization and the Transformation of IT Governance," *MIS Quarterly* 42, no. 4 (2018): 1225–53.