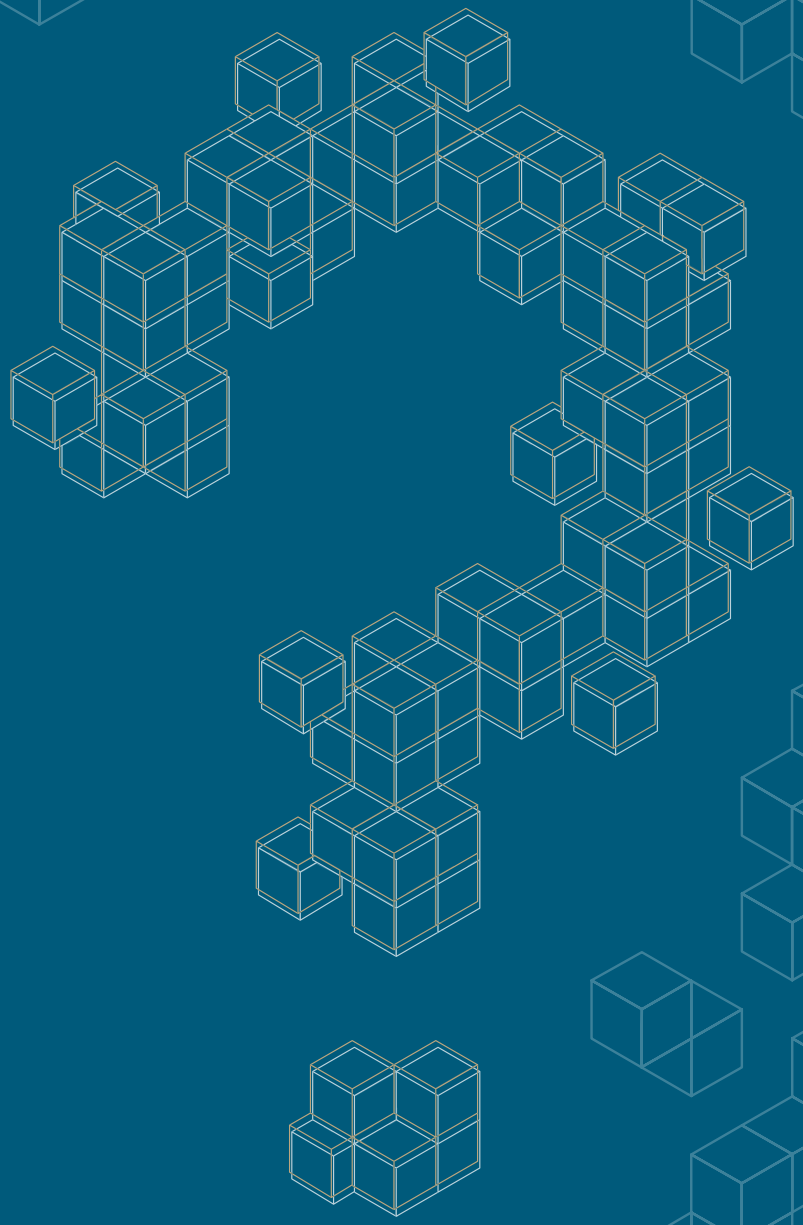
WHEN IS(N'T) BLOCK-CHAIN RIGHT?



A DECISION GUIDE FOR SUPPLY CHAIN PROFESSIONALS

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THE UNIVERSITY OF TENNESSEE KNOXVILLE

GLOBAL SUPPLY CHAIN INSTITUTE

APRIL 2021

IN MEMORIAM:

MARY HOLCOMB

Mary Holcomb, Gerald T. Niedert Professor of Supply Chain Management and Martin and Jean Mills Faculty Research Fellow in the department of supply chain management at the **University of Tennessee, Knoxville**'s **Haslam College of Business** passed away on Friday, February 12, 2021. Born and raised in Oak Ridge, Holcomb received her bachelor's, master's, and doctorate degrees all from UT. After earning her PhD in logistics and transportation, she spent two years at Iowa State before returning to UT where she taught for more than 28 years.

Mary was an iconic member of the **Global Supply Chain Institute** (GSCI), helping hundreds of companies solve complex supply chain issues and implement benchmark systems. GSCI has published 25 industry-focused white papers since 2013, and Mary co-authored three of those papers:

- Transportation 2025 Mega Trends and Current Best Practices (2017)
- Future Trends Shaping Transportation (2020)
- When Is(n't) Blockchain Right? (2021)

Mary's research had a significant impact on nearly all of GSCI's white papers, including significant contributions to the following:

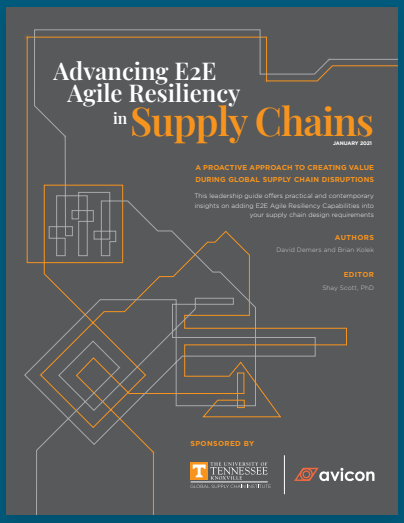
- The New Tenets of Transportation (2014)
- Young Professional Women's Perspectives on Supply Chain Diversity and Inclusion (2019)
- End-to-End Supply Planning Framework and Key Concepts (2019)

Mary's research and teaching had a meaningful and far-reaching impact on the field of supply chain management, specifically transportation. Holcomb's and Karl Mandrodt's annual review of the logistics and transportation industry was published for the 29th time in 2020 and was a critical resource regarding the future of the industry. Additionally, her pioneering research on transportation as a revenue generator continues to significantly influence how many companies manage transportation. "As transportation emerged from the regulatory era, Mary was a pioneer in recognizing how service could drive revenue and financial performance in the industry. She became a go-to source for understanding trends that drive the industry," shared Ted Stank, Bruce Chair of Excellence and co-faculty director, UT's Global Supply Chain Institute.

Perhaps the most meaningful impact Holcomb had was on her colleagues and students. To her colleagues, Mary was the heart and soul of UT's supply chain management department. Her enthusiasm and desire to improve helped drive UT's supply chain program to its place amongst the top programs in the world. She was always a proponent of doing what was best for the department. Chad Autry, department head, supply chain management at UT, highlighting her many contributions over nearly three decades explained, "We are an adventurous and innovative group, and any time we came up with something that was truly game-changing, especially for our students, you can bet Mary was at the center of it. She was always looking for a way to make a student's time at UT better, to connect them with an internship opportunity, or find a better way to teach a complicated concept. That's just how she was. I received countless notes of gratitude on her behalf."

Mary was also beloved by the thousands of students she instructed and mentored. Madison Hutts, a senior studying supply chain management at UT, shared that "Dr. Holcomb had a passion for teaching, learning, and engaging unlike any professor I've ever had. She put her heart and soul into all we did. Dr. Holcomb was 100% grit and 110% passion. It was a blessing to know her as a professor and friend."

While we say farewell to Mary, we acknowledge her tremendous impact on the profession and the many lives she touched. If you would like to join UT in honoring the life and legacy of Mary Holcomb by supporting the newly established Dr. Mary C. Holcomb Scholarship Endowment, please visit **giving.utk.edu/Holcomb**.



Global Supply Chain Institute

Industry-Focused White Papers

The Global Supply Chain Institute in the Haslam College of Business at the University of Tennessee, Knoxville, has published more than 25 white papers with industry partners, extending relationships and engagement with industry and shaping the future of supply chain management. These papers reveal supply chain's best practices and help address the industry's greatest challenges. Research from these white papers has appeared in publications such as Supply Chain Management Review, DC Logistics, Harvard Business Review, the Wall Street Journal, Forbes, and more.

The entire white paper library
is available for download at
supplychainmanagement.utk.edu/research/white-papers

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INTRODUCTION: ROI OF BLOCKCHAIN

As soon as someone mentions blockchain in a meeting, eyes begin to roll. "There goes Jim again with his 'tech speak.' What does this bitcoin technology have to do with the real work of supply chain?" Chuckles ensue and the conversation dies. At another company, Sarah takes a different route. She begins the meeting by talking about a real problem they are currently battling. Their supply chain is becoming more fragmented. In their quest to be resilient and agile, they have taken on new production partners and expanded their network of supply chain partners to move goods through the end-to-end supply chain. Their small group of trusted partners has expanded to a large group, many of whom they don't know well or trust. It gets more complicated when this network is extended to second- and third-tier suppliers. Sarah proposes, "What we need is a way for all these partners to communicate with each other in a secure, digital format. We can't have the right hand not knowing what the left hand is doing." What is the mysterious technology Sarah speaks of that could coordinate a distributed network with commercial trust? Blockchain!

Like Sarah, the Advanced Supply Chain Collaborative (ASCC), a joint initiative of the Global Supply Chain Institute, the Department of Supply Chain Management and the Department of Business Analytics and Statistics at the University of Tennessee, Knoxville's Haslam College of Business, takes on real problems and opportunities that can be addressed at the intersection of supply chain and technology. This white paper stems from research conducted with industry-leading companies like Amazon, Mondelēz International, and Pfizer over the course of approximately 18 months. The central question posed by ASCC member companies was, "What is the ROI of blockchain?"

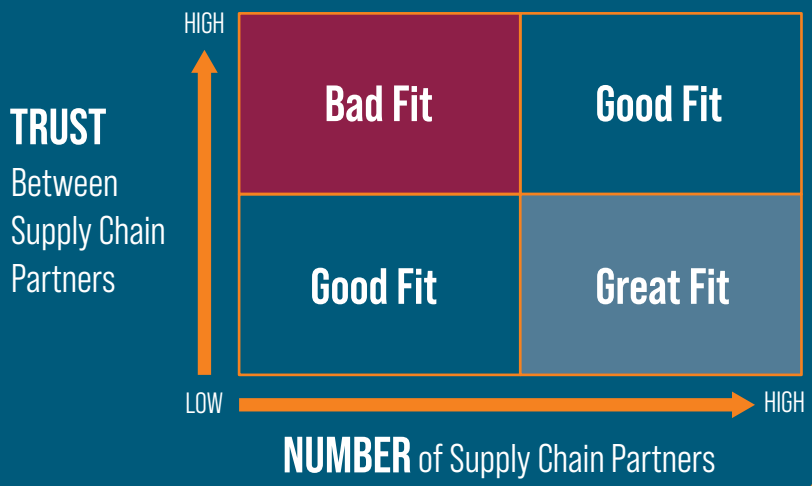
Spoiler alert: Like returns on any other technology applied to business, ROI (return on investment) on blockchain depends on how and where it is applied. Blockchain has been one of the most-hyped technologies of the last decade. Market research firm International Data Corporation (IDC) forecasts company spending on blockchain to reach nearly $4.3B in 2020 and grow to $14.4B by 2023.[1]

However, the skeptical case is not unfounded. The technology can be complex, the implementation challenging, and the scalability and interoperability limited by a lack of standards. Further, the technology is too often implemented in technical pilots not tied to business value or used as a database solution when existing technologies could do the job better for less cost.

[1] "IDC FutureScape: Worldwide IT Industry 2018 Predictions," Oct. 2017. IDC #US43171317. Acclivis.

Despite the challenges, to dismiss blockchain and its value to the supply chain would be a mistake. When many partners or competitors must share information within an end-to-end supply chain or need to execute commercial transactions where trust is limited, blockchain is adding real value to real companies today (see Figure 1).

Figure 1. Enterprise Blockchain Fit



Source: UT ASCC

UT's ASCC believes that the ROI of blockchain is not about blockchain. Instead, it's about determining if blockchain can be an enabler in achieving one's strategy. The same can be said about any other Industry 4.0 connecting and thinking technologies. Consider artificial intelligence (AI). Companies are spending a great deal of money hiring data scientists and trying to figure out how to use this powerful technology in their businesses. For most organizations, the payback from these investments are still on the horizon. Still, predictive or prescriptive analytics promise that the payoff will come in both cost savings and new revenue opportunities, and the same could be said for blockchain.

To help determine the correct blockchain path for a company, this white paper is organized into five sections; 1) Blockchain 101, 2) Current Limitations, 3) Current Benefits, 4) Building a Blockchain, and 5) Blockchain Best Practices. In the last section, we'll present two tools that were developed as part of this research – the Blockchain Screener and Blockchain Decision-Support Framework. Used in combination, these tools provide a structured approach to assessing the timing and extent of an investment in blockchain.

The grand challenge of blockchain is the gap between theory and implementation. However, once a company has "crossed through that jungle" as one interviewee put it, they have a path that can be easily followed. We'll start the journey with a Blockchain 101 Tutorial.

BLOCKCHAIN 101: Understanding the Technology

Blockchain is simply a shared ledger used to process, record, and track transactions in a business network. Think of it as a physical ledger built for the digital economy. In this ledger a company can transact the exchange of both tangible assets like toasters and intangible assets like patents on toasters. A transaction is recorded in the digital ledger as a "block" of data and an address called a "hash" is created for each block. Each new block of information is validated by participants in the network and connected to the block before it. As more blocks are added, the chain becomes stronger. Each block is connected to the one before it and after it, making it impossible to remove a block without detection. This is how blockchains create a shared ledger that all participants in the network can trust.

Each block is CONNECTED to the one before it and after it, making it IMPOSSIBLE TO REMOVE a block without detection.

This is how blockchains create a shared ledger that all participants in the network can trust.

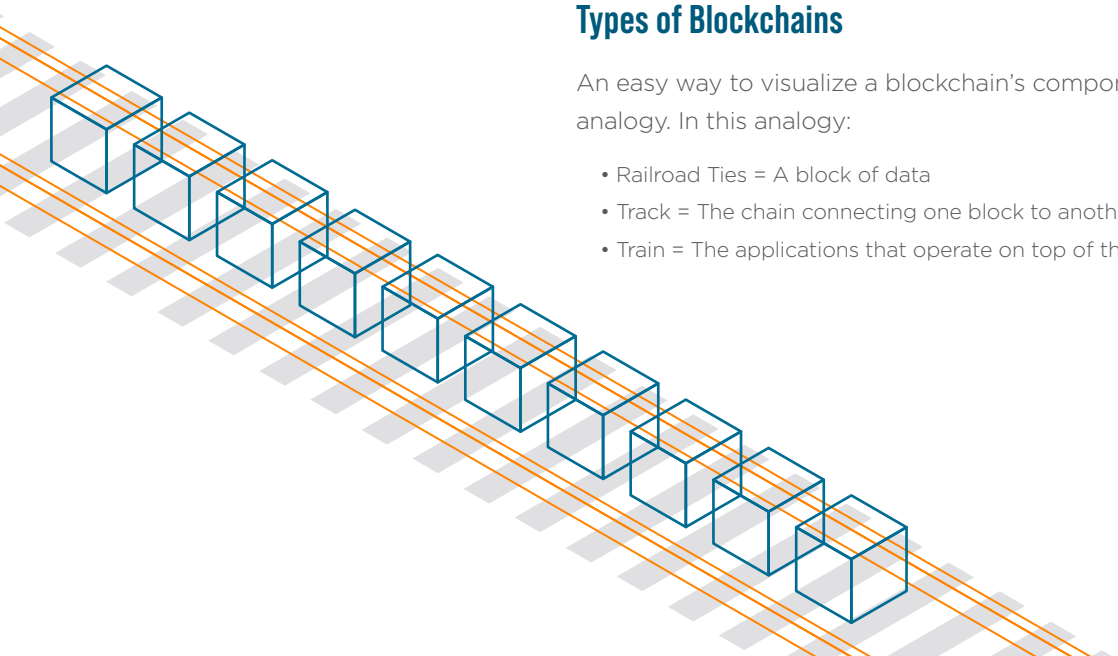
The primary use of blockchain technology in the supply chain is information exchange. Since blockchain acts as a shared ledger, multiple participants in the supply chain will have the exact same information about transactions from raw materials to a finished product at a customer's doorstep (in other words, there is a single source of truth). The use of blockchain in supply chain management applications is "expected to grow at an annual rate of 87 percent and increase from $45M in 2018 to $3314.6M by 2023" (Kamilaris, Fonts, & Prenafeta-Boldú, 2019). Operations and supply chain professionals see blockchain technology as an opportunity to bolster data capture and operational efficiencies.

Note: This technology may not be the best solution for all supply chains, and implementation of the technology will vary based on the firm's purpose. In many instances, a business' problems can be solved with existing technologies and processes, despite the appeal of new technology.

Types of Blockchains

An easy way to visualize a blockchain's components is to use the train tracks analogy. In this analogy:

- Railroad Ties = A block of data
- Track = The chain connecting one block to another
- Train = The applications that operate on top of the train tracks



Multiple people need to agree on where to place each railroad tie. The railroad ties are put in place and the track is placed over the ties. The train runs over the track's, connecting points along the track. Theoretically, someone could move the railroad ties, but not without removing the track, requiring agreement from others. This is why blockchain is said to be immutable.

Just like railroad ties can be constructed out of different materials, information blocks can be built using different coding platforms. Hyperledger and Ethereum, shown in Figure 2, are the two most popular smart-contract-capable blockchain coding platforms. Hyperledger is the preferred platform for B2B operations and is used by large enterprises. Ethereum is a popular choice for generalized applications and is mostly used for P2P (peer-to-peer) and B2C (business to consumer) operations. Technology companies like Amazon, IBM, Microsoft, and SAP build applications, i.e., trains, which run on top of railroad ties and tracks, using Hyperledger, Ethereum, or other blockchain coding platforms.

Figure 2. Blockchain Platforms

PLATFORM	INDUSTRY FOCUS	COMPANIES (EXAMPLES)	GOVERNANCE	LEDGER TYPE
Hyperledger	AWS Managed Blockchain IBM Food Trust Azure Blockchain Service SAP Multichain TradeLens	Allianz Bumble Bee Cargill Walmart BBW Maersk Nestle	Linux Foundation	Permissioned For **Private** Blockchains
Ethereum	AWS Managed Blockchain Azure Blockchain Service	Anheuser-Busch InBev HPE Overstock.com	Ethereum Developers	Permission-less For **Public** Blockchains

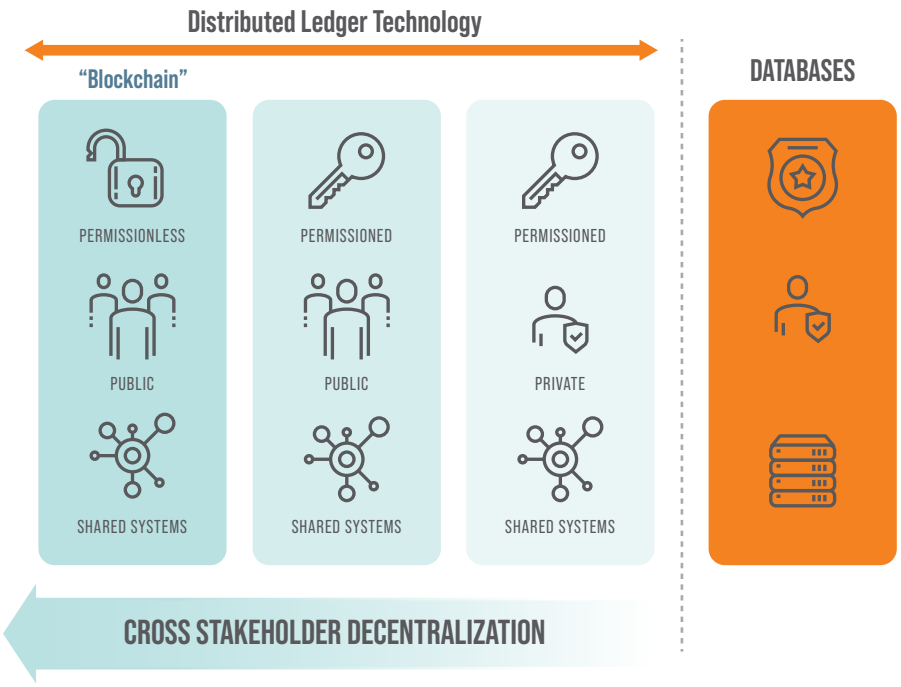
UT Analysis, Various

Blockchain is a type of distributed ledger. Instead of data being kept in one location, as in a traditional ledger, distributed ledgers use independent computers to record, share, and synchronize transactions. Using this technology, multiple participants in a supply chain will have the exact same transactional, end-to-end supply chain information (a single source of truth).

There are three different types of blockchains – public, private, and hybrid. Any user in a public blockchain can access and read the information using its unique identifier (i.e., barcode, QR code, RFID). Private blockchains will have a limited number of users that are given an access key. Hybrid blockchains use elements of both public and private blockchains. For example, a hybrid Blockchain might have an unlimited number of users but give a subset of users permission to use certain information stored on the Blockchain. As more businesses explore the return on investment in this technology, groups of executives, information technologists, supply chain professionals, and developers are building consortiums to expedite blockchain implementation. These consortiums could be considered another type of hybrid blockchain.

Blockchain shared ledger applications can be either "permissioned" or "permissionless" (see Figure 3). Permissioned means that one must be invited to join the blockchain. These private blockchains often are run by a consortium of companies in an industry or by a company with tremendous market influence. A permissionless blockchain is public, which allows anyone to join it, if they agree to the terms of use.

Figure 3. Cross Stakeholder Decentralization



Source: Mulligan, C., Zhu Scott, J., Warren, S., & Rangaswami, J., "Blockchain Beyond the Hype A Practical Framework for Business Leaders," World Economic Forum. Retrieved from Mulligan, Zhu Scott, Warren & Rangaswami, 2018.

Importantly, emerging technologies do not gain their power in isolation, but in combination with other technologies. Hence, blockchain is only a part of a solution to be deployed. For example, sensors (i.e., Industrial Internet of Things or IIoT) can capture in-transit data, feed the data to a secure blockchain, and allow AI/ML algorithms to interpret the data, potentially using high-performance computing to shorten turn-around time on simulations. End-user computing (EUC) allows users "at the edge" (non-programmers) to create working applications based on the intelligence they've received from the original IIoT data.

Blockchain is still a mystery for many companies, making it difficult for supply chains to adopt a one-size-fits-all system. Businesses may choose to give various departments access to some blockchains while blocking access to others. Permissions can be granted to read and/or write to the blockchain. The more permissions are needed to access the blocks, the more private the blockchain is.

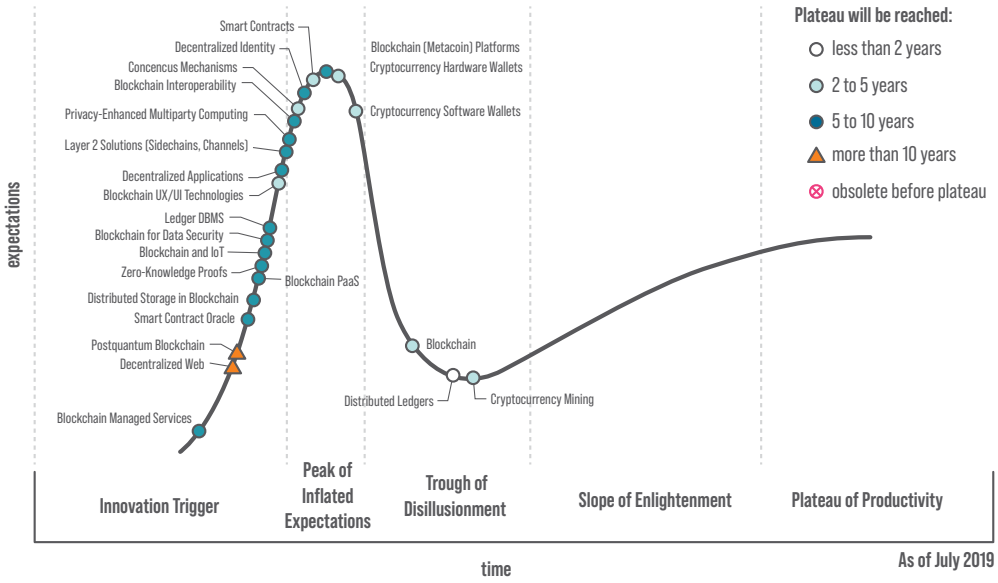
How is blockchain different than other technologies? Simply put, there is no single owner or central controlling authority for data on the chain. As changes are made to the blockchain, each user has access to these changes in the server. There is no need for a trusted third party to verify the data stored in each block because the blockchain architecture creates a network of users who reduce the risk of one party controlling the database. **Blockchain provides users with authentic data which cannot be adjusted without participating parties being aware of such adjustments.**

A common point of confusion is whether blockchains are distributed (aka shared) or decentralized. To be clear, a blockchain is distributed because many parties in the supply chain hold copies of the ledger. This is an important distinction. Although the information is shared across multiple parties, decision making still can be centralized. If blockchains were decentralized, then there would be no single point where decisions were made. A decentralized system is a subset of a distributed system. The primary difference is how and where decisions are made and how the information is shared throughout the control nodes in the network.

Adoption Timeline

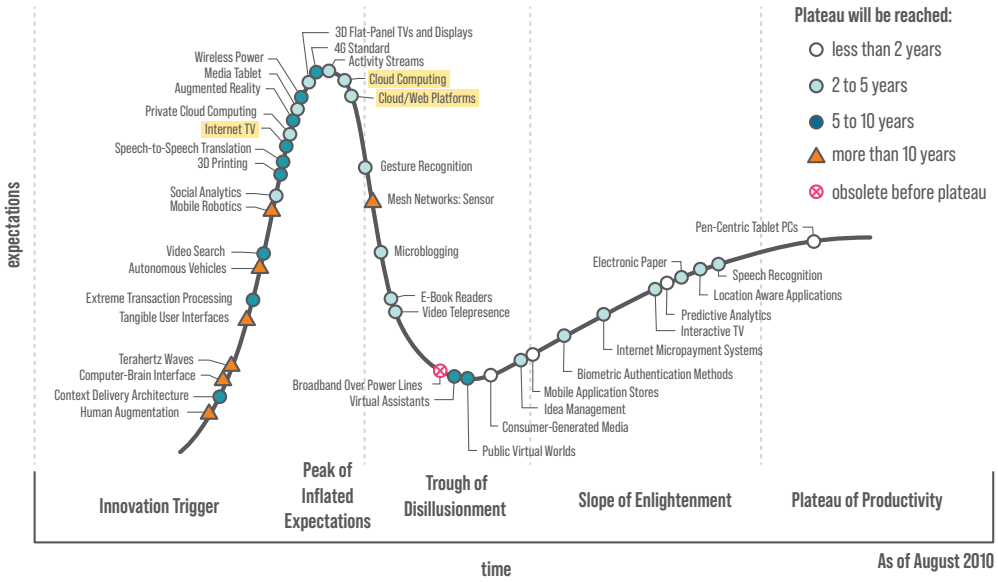
In October 2019, Gartner released a "Hype Cycle for Blockchain Technologies" that depicts the growth of this technology and the timeline it will take to achieve transformational change (see Figure 4). In most cases, this change will occur five to ten years in the future.

Figure 4. Hype Cycle for Blockchain Technologies



While five to ten years from now may make blockchain seem a long way off, it's important to realize that technologies such as streaming and cloud were in a similar situation in 2010 (see Figure 5). Streaming overtook cable in 2019 and the $266B cloud computing market has transformed industries.

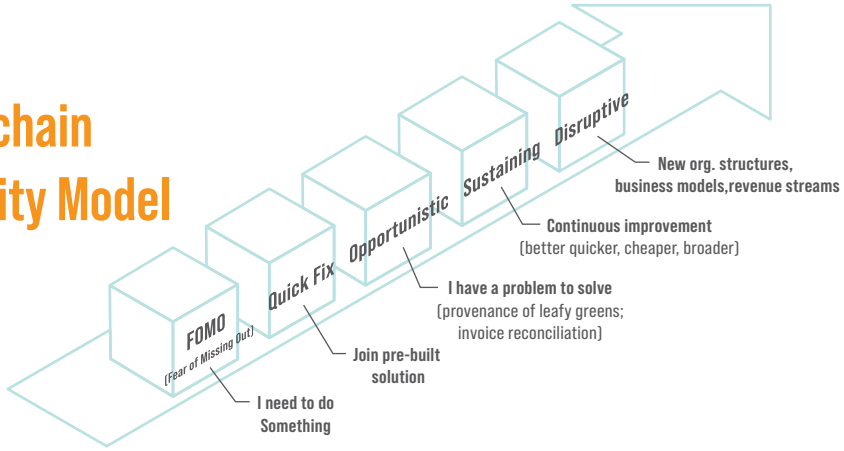
Figure 5. Hype Cycle for Emerging Technologies



Today, many companies are interested in supply chain applications of blockchain as evidenced by the 500+ members of BiTA (Blockchain in Transportation Alliance) and 100+ participants in the TradeLens blockchain for ocean freight. For most companies, hype and hope define the endpoints of the blockchain continuum (see Figure 6). At one end is, "We need to do something." At the other end is, "We want to transform business models." In between is, "We have a problem to solve." Currently, most companies fall in the middle, and are engaged in proof of concept (or pilot projects). What they do beyond their pilot project ultimately will determine whether it is hope or hype.

Figure 6.

Blockchain Maturity Model



Blockchain, Smart Contracts, and Cryptocurrencies

The most likely application of blockchain for secure transactions in the supply chain industry will be smart contracts. Smart contracts work when a set of guidelines or conditions are met between the parties to execute a certain action. For example, in manufacturing, if a customer's distribution center dips below an inventory level defined by the smart contract, that would trigger an order to the manufacturer to produce and send more inventory to reach the desired level. Blockchain technology empowers firms to transform how contracts are carried out in a transactional process. Implementation of smart contracts gives all participants confidence in where the product is and who owns the product at any given time throughout the supply chain. Operational smart contracts can be linked to the use of cryptocurrencies such as Bitcoin or Ethereum to quickly exchange goods and services for financial benefit.

Smart contracts allow for the conversion of human-readable language, like legal contracts, into computer-readable language. Smart contracts are less subject to interpretation than traditional contracts. A simple smart contract can be explained as a series of if/then statements. IF someone puts a dollar into the vending

What would a SMART CONTRACT for invoice reconciliation look like?

IF the transportation company delivers the shipment AND it's in good condition AND it was on time AND it was complete, THEN disburse payment to the trucking company and vendor.

machine AND they press the button for a Snickers Bar, THEN dispense a Snickers Bar. It's easy to see how valuable smart contracts could be for applications such as invoice reconciliation. IF the transportation company delivers the shipment AND it's in good condition AND it was on time AND it was complete, THEN disburse payment to the trucking company and the vendor.

In 2008, Satoshi Nakamoto wrote, "Bitcoin: A Peer-to-Peer Electronic Cash System," a paper about the exchange of currency in a peer-to-peer network. Bitcoin was the first example of what would later become the standardized name of "blockchain," and today, it is the most common cryptocurrency. Banks are the third party managing the current exchange of money. Blockchain technology as a cryptocurrency removes the need for a bank to ensure the exchange of monetary value. Peer-to-peer networks enable players in the blockchain to approve or deny exchanges. Cryptocurrencies can be in the form of payments or applications.

All CRYPTOCURRENCY is blockchain technology, but not all BLOCKCHAIN is cryptocurrency.

All cryptocurrency is blockchain technology, but not all blockchain technology is cryptocurrency. Whether a platform supports the exchange of monetary value, aka cryptocurrency, depends on which blockchain application is used. The transfer of monetary value within a cryptocurrency blockchain is called a token. The larger the network grows, the higher the value of a single token. The cryptocurrency's value could be related to the value of a stock on Wall Street. As more investors buy stock, the stock's value increases. Cryptocurrency's popularity has boomed in the last 10 years, creating a competitive market.

BLOCKCHAIN 201:
Understanding the Costs and Benefits

One of the primary objectives of this exploratory ASCC project is to better understand the benefits, costs, and risks associated with developing and deploying a blockchain solution. As noted on page 3, company **spending on blockchain is expected to reach almost $4.3B in 2020 and grow to $14.4B by 2023.**[2] With investing in blockchain growing at such a significant rate, companies must gain more comprehensive knowledge about the drivers for use cases.

Indeed, most companies are spurred to begin their blockchain journey by a need to improve their business. A study by Forrester Research Inc. reported that the top reasons enterprises consider blockchain is the preservation of data integrity and the ability to build new revenue or business models. Other prominent factors for implementing blockchain solutions include increasing operational efficiency and reducing costs.

Blockchain benefits include **INCREASED EFFICIENCY,** improved visibility and tracking of goods and products, data integrity/ compliance, and new products or services.

Because most blockchain projects currently are private and require permission to gain access, finding more granular information on the ROI, costs, and risks associated with investments can be difficult. Most companies use broad characterizations such as benefits and barriers to describe initial pilot projects and lessons learned from implementation. Benefits noted to date include increased efficiency, improved visibility and tracking of goods and products, data integrity/ compliance, and new products or services. These value drivers have constituted the primary rationale for pilot projects. While some projects can be gauged using traditional metrics, determining blockchain ROI is more elusive.

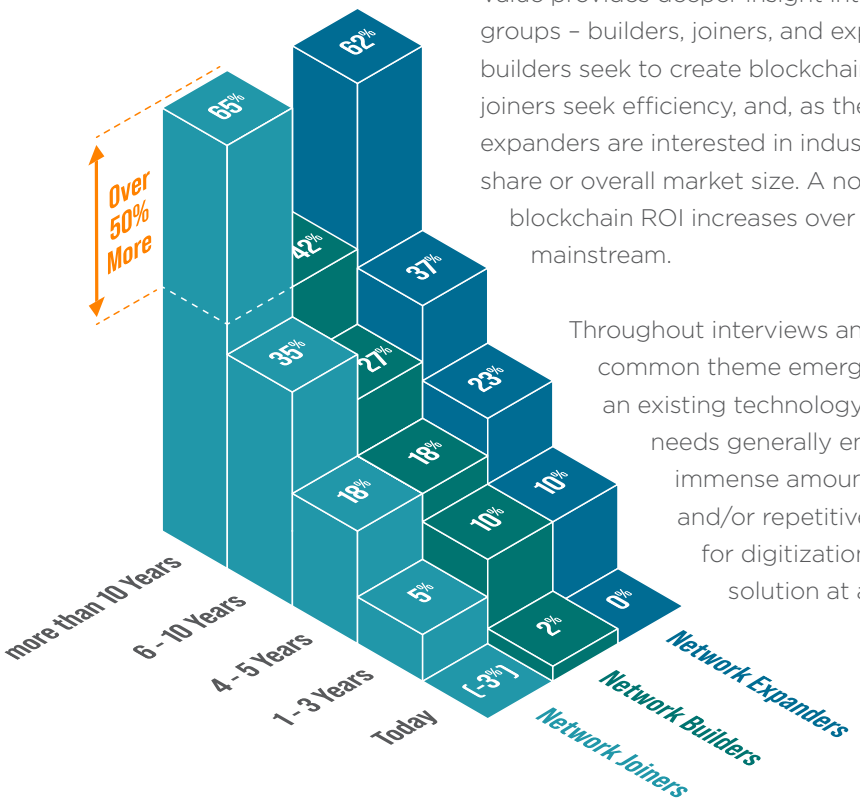
Benefits of Blockchain: A Macro-level Perspective

A recent study by the World Economic Forum, in collaboration with Accenture Research, asked 550 individuals across 13 industries about the value proposition for blockchain. The results parallel the Forrester research but offer additional insight by industry sector into the perceived benefits from using blockchain. For energy, healthcare, travel, insurance, and retail sectors, the primary value was full traceability of any information on the blockchain. The ability to ensure that data has not been tampered with was a top priority among the banking, public service, speed and efficiency. Several companies cited these value-added outcomes as their reason for starting a blockchain pilot project.

[2] "IDC FutureScape: Worldwide IT Industry 2018 Predictions," Oct. 2017. IDC #US43171317. Acclivis.
[3] Forrester Research Inc., "Seize the Day: Public Blockchain is on the Horizon," November 2019.
[4] World Economic Forum

Figure 7.

Blockchain ROI



A study conducted by blockchain solution provider IBM's Institute for Business Value provides deeper insight into the expected blockchain ROI across three groups – builders, joiners, and expanders (see Figure 7). As defined by IBM, builders seek to create blockchains within their industry that provide new services; joiners seek efficiency, and, as the title implies, they join existing networks; expanders are interested in industry or cross-industry networks to grow market share or overall market size. A notable takeaway can be seen in the results – blockchain ROI increases over time as networks grow and become more mainstream.

Throughout interviews and other sources compiled for this project, a common theme emerged: Blockchain should only be considered when an existing technology will not address a combination of needs. The needs generally encompass: 1) a rapid deployment of assets, 2) an immense amount of data, and 3) the elimination of non-value and/or repetitive tasks. Further, blockchain is not a substitute for digitization or another technology that can deliver a quick solution at a lower cost with less risk.

Barriers to Implementing Blockchain

The factors that constrain companies from implementing blockchain are familiar and often present with the adoption of new technologies. First and foremost is the cost of developing and implementing blockchain solutions. This barrier is interrelated with the second issue, which is the lack of a clear business case for the technology. **Without a thorough understanding of what matters most to a company and how blockchain can solve those pain points or enable areas of opportunity, it will not be possible to calculate an ROI germane to the company.**

A tremendous amount of hype surrounds blockchain that positions it at both ends of a spectrum. It is seen as the means to transform business processes and as the next fad doomed to under-deliver due to a lack of expertise and upper- and mid-level management's lackluster commitment to effective implementation.

This section concentrates on the quantifiable costs and benefits that emerged from numerous interviews with companies at various phases of blockchain implementation. In addition, examination of a wealth of published research and studies contributed to and expanded upon knowledge gained from the interviews.

Consider blockchain when existing technology DOES NOT address:

1. A Rapid Deployment of Assets
2. An Imense Amount of Data
3. The elimination of Non-Value and/or repetitive tasks.

THE COST OF BLOCKCHAIN IMPLEMENTATION

Three primary phases of blockchain implementation are recognized by blockchain solution providers and industry adopters. Figure 8 presents the three phases, which are: 1) pilot project, 2) commercial market, and 3) network of networks. Because blockchain is new and innovative technology, companies begin their exploration of this solution by implementing a pilot project. The purpose of a pilot project is to establish proof of concept. The objective of testing is to confirm that the technology is feasible, viable, and applicable in practice.

Figure 8. Primary Phases of Blockchain Implementation

One of the first decisions a company makes that affects cost is about the type of blockchain – private (permissioned) versus public. The cost associated with implementing a private blockchain solution includes development, whereas a public blockchain will seek to recoup the development cost through various means such as onboarding, membership, transaction fees, or some combination of these. A later section discussing the benefits of blockchain will provide more information on the commercial market's new business opportunity. Forrester's study reported that approximately two-thirds of the participants have chosen to start networks rather than join an existing one.[5]

Phase I: Pilot Project

Pilot projects often seek to address a specific problem or issue. The number of partners involved in a pilot project range from three to five; the scale is purposely small, as the lead company is assessing tangible and intangible benefits of adopting this technology. A pilot project enables all participants to determine whether blockchain is better than current practice, the ease or difficulty of using the technology, and any relative advantages resulting from its adoption. Case studies offered in a later section of this report detail several pilot projects reviewed as part of this research.

[5] Forrester Research, Inc. "Seize the Day: Public Blockchain is on the Horizon," November 2019.

The costs associated with a blockchain pilot project are straightforward. As previously noted, a private blockchain will incur internal information technology (IT) and developer expenses, and the costs for engaging an external company to help with the blockchain prototype. The service fees paid to an outside entity depend primarily on the duration and complexity of the project. In addition to those expenses, the cost of internal employees (other than developers and IT) involved in the pilot project should also be included.

Phase II: Commercial Market

Blockchain is best leveraged to solve a myriad of problems in concert. As such, the next business model involves developing a blockchain solution that can be commercialized. Bringing blockchain technology to market entails increasing scale and complexity; additional developers and IT efforts will be required. The cost for this phase also includes the resources needed to create a governance model and advising board that will determine how the blockchain will be monetized. During this phase, the company with the blockchain intellectual property rights decides whether the fee structure will be membership- or transaction-based. In addition to internal employees involved at this stage, many of the decisions comprise legal and business resources whose costs must be included. The external entity engaged in Phase I may also be involved in bringing the blockchain solution to the market. If so, those service fees should be incorporated.

Phase III: Network of Networks

The ongoing use of blockchain brings about the development of a network of networks. With an increasing number of companies joining the blockchain, the lead blockchain company will need to build additional features and upgrade the platform periodically. This involves developers and IT resources to operate and support the blockchain. Internal personnel will also be required to onboard new members and to take ownership of member relationship management. As with the other phases, an external company often is used to guide the development of the ongoing ecosystem. The fees for this service and continued service costs can vary depending on several factors, including project duration and complexity.

Blockchain Platform Cost

A common cost for each type of implementation involves the cloud platform and the blockchain infrastructure necessary for the technology. Fees for data storage and retrievals, data transfer, infrastructure administration, resiliency, and business continuity requirements are structured on network usage and number of peer nodes. As with the number of partners in a pilot project, the number of peer nodes would be relatively small (three to five). The number of peer nodes increases with each subsequent business model, with the network of networks consisting of the largest number of nodes.

ASSESSING BENEFITS

While the long-term strategic goal may be to transform the existing infrastructure or consider new business opportunities, most companies **THINK BIG but START SMALL.**

At the beginning of the blockchain journey, companies use the technology to improve existing products and services. While the long-term strategic goal may be to transform the existing infrastructure or consider new business opportunities, most companies think big but start small.[6] A pilot project allows a company to improve operational efficiency and reduce its risk through data accuracy and enhanced trust. To estimate an ROI, the benefits derived from blockchain must be quantified. Efficiency improvements can be classified broadly into two categories: cost savings and cost prevention.

Cost Savings

The pain points that often motivate a company to seek a blockchain solution typically involve streamlining and speeding up administrative tasks. For example, freight bill audits and payments are a substantial cost and pain point for large companies. The numerous conflicts that must be resolved prior to payment remittance can be quantified by determining the following:

- Average number of conflicting invoices
- Average cost to resolve the conflict
- Estimated reduction in conflicting invoices by using blockchain

Streamlining this process can result in appreciable savings. An oil and gas use case documented by the World Economic Forum reported that the blockchain solution resulted in a reduction in freight spend of five percent, or an equivalent of $100M.[7]

Other cost reductions can be realized by using blockchain to replace legacy systems and tools. Blockchain can simplify the coordination of common systems records and data that previously would take supply chain members considerable resources to reconcile. In addition to reducing administrative costs, the blockchain solution enhances trust by providing a single source of truth. Increased visibility and faster data transfer are also tangible enhancements from which the entire supply chain benefits. However, unlike with the freight bill audit and payment example, quantifying the savings gained through these improvements is difficult.

[6] Odell, S. and J. Fadzeyeva, "Emerging Technology Projection: The Total Economic Impact of IBM Blockchain," Forrester Research Inc., 2018.
[7] World Economic Forum, "Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits," July 2019.

Cost Prevention

The tamper-evident nature of blockchain reduces the likelihood of fraud and data breaches. Sharing and storing encrypted data creates a more secure environment, which is important to many companies. In a study by Accenture Strategy, only 30 percent of CEOs reported having confidence in their data security.[8] The risk exposure is significant. The 2017 cyberattack of Maersk resulted in a $300M loss for that company alone. The damage to other companies due to the data breach was estimated to be more than $10B. The magnitude of possible loss is immense; evaluating the risk exposure from fraud and determining the degree of risk reduction by using blockchain can be a potential benefit.

Food industries have issues with spoilage and product recall. Blockchain has been shown to assist in reducing food waste by shortening the time it takes to reach the final consumer. The technology also enables the speedy identification of products by a supplier in the event of a recall, thus precluding the need to recall the entire inventory. Such events, when handled by blockchain, can avoid massive inventory losses and, just as importantly, enhance public trust. According to Walmart, "With blockchain, research that used to take seven days can now take as little as 2.2. seconds, tracing contaminated foods to their source, fast."[9] An evaluation of the activities that expose a company to loss and damage, along with the potential for reduction if a blockchain solution is implemented, can be used to calculate the preventable cost.

With blockchain, research that used to take SEVEN DAYS can now take as little as 2.2 SECONDS tracing contaminated foods to their source, fast.

New Business Opportunity

As noted in Figure 5, after a proof of concept has been established, a company typically decides to market an extended version of its blockchain commercially. In bringing the solution to market, the goal is to determine how many supply chain partners see value in this offering. The idea is to build a consortium quickly to monetize the blockchain. Two approaches to this new business opportunity can be used: membership or transaction. With the former approach, a new member in the blockchain would pay a one-time onboarding fee along with an annual membership (or subscription) fee. An estimated revenue stream can be calculated based on the expected number of members and the associated fees.

The second approach to marketing the blockchain commercially is transaction based. With this method, the blockchain owner determines the price per transaction depending on the number of transactions per customer. As the number of blockchain members increases over time, the blockchain owner is incentivized to decrease its per-transaction fee.

A company's ability to capitalize on this business opportunity depends on the actual blockchain solution offered to potential new members and the value they perceive from joining the consortium. If a company wants to supply leafy greens to Walmart, joining Walmart's blockchain is the price of admission.

[8] Abbosh, O. and K. Bissell, "Securing the Digital Economy – Reinventing the Internet for Trust," Accenture Strategy, 2019.
[9] Smith, M, "In Wake of Romaine E. coli Scare, Walmart Deploys Blockchain to Track Leafy Greens," Walmart Communications, September 24, 2018.

PROOF OF CONCEPT: DOCUMENTED CASES

A large 3PL has initiated its own blockchain technology to minimize transit time, increase revenues, and offer the customer shipment transparency. Worldwide shipping players continue to be challenged by customs clearance processes. Blockchain in the supply chain provided by this 3PL would enable the shipments to quickly clear customs without the need for a paper trail. It also would reduce total transit time by minimizing the time shipments are spent in customs clearance. The total inspection time of the shipment also would be reduced, as would the number of people needed to verify shipment details. Reductions in labor and inspection directly affects the bottom line, leading to increased profitability for the 3PL. Lastly, by providing transparency to the customer, should an existing shipment be replaced due to damage or mistakes, the customer can request the shipment be canceled or redirected in real time. Confidence that the customer is receiving the correct shipment of the expected quality will strengthen the relationship with the 3PL and potentially lead to increased business (and revenue).

It is important to understand that the 3PL is not replicating current processes simply by digitizing them, but rather, is establishing a new process. The goal of the logistical blockchain is that each block triggers new data that should be shared with one or many participants. If the 3PL receives a purchase order, the blockchain would prompt a certificate of origin for the manufacturer. When the customer receives the shipment and scans the barcode, the certificate of origin would be visible. The intent is not to replicate an ERP or EDI system but rather to use the blockchain to share useful information in a seamless manner that removes the need for third-party verification.

In 2019, Nestlé launched its "Chain of Origin Coffee," using Amazon's blockchain technology to trace the original source of the coffee bean. Coffee is the second leading commodity traded around the world, with consumers clamoring to know where their food and drinks are coming from, Nestlé feels traceability will improve the customer experience. With Chain of Origin Coffee, **Nestlé has built confidence not only in the quantity of the coffee traded, but also the quality.** Using blockchain technology enables the customer to trace coffee beans to the specific, originating farm. It enhances the overall customer experience and empowers the company to quickly correct mistakes.

The Plastic Bank is a non-profit organization with a mission to turn plastic left on beaches in Haiti into cash. The bank helps fight poverty in Haiti by encouraging people to recycle plastic through a collection facility, which then pays them in

cryptocurrency through an online banking platform. Founder David Katz said in his TED Talk, "preventing ocean plastic could be humanity's rich opportunity." This blockchain helps nourish those in need while cleaning local areas of plastic waste.[10]

Beyond the Pilot Project

Understanding the decision process that companies employ to determine if blockchain is the appropriate technology for their needs is presented in a subsequent section of this report. This section assumes that a company has begun, is in the midst of, or has completed a pilot project. Given the success of a pilot project, a company would most likely determine the next strategic step in implementing blockchain.

[10] Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of Blockchain technology in agriculture and food supply chains. Trends in Food Science & Technology, 91, 640-652. doi:10.1016/j.tifs.2019.07.034

BLOCKCHAIN 301: Lessons from the Field

ASCC's examination of the ROI of blockchain revealed both optimism and skepticism. One camp can be described using the analogy of the Segway, a much-hyped innovation that ended up relegated to a few applications (e.g., mall cops and city tours). In the other camp are those that see the transformative potential of the technology's characteristics:

- Shared ownership of data with no arbitrary delegation
- Single source of truth
- Immutable (any changes to the data can be tracked and audited)
- Data distributed across a secure network

A better understanding of its **UNIQUE BENEFITS** coupled with the emerging case studies demonstrating **SUBSTANTIAL VALUE** will lead to the highly anticipated **ROI** for specific applications over the next three to five years

ASCC Viewpoint: What's the ROI of Blockchain?

While the ROI of blockchain is limited in the short term, the ASCC project results reveal that a better understanding of its unique benefits coupled with emerging case studies demonstrating substantial value (see Walmart Canada/DLT Labs case study on page 26) will lead to the highly anticipated ROI for specific applications over the next three to five years. Long term, the ultimate value of blockchain will not be unleashed until industry-level standards are set and accepted. These standards will allow a network of networks to be created, enabling interoperable applications to scale quickly and easily.

The ROI in blockchain today can be found in a limited number of applications, such as reducing administrative burdens, costs of invoice reconciliation, and tracking the provenance of goods. Most companies are still in various stages of pilot programs that, by their very nature, are not profit producing. Further, many of these pilots are being run by R&D or IT groups with little connection to the commercial business engine of the company.

When to get in the game was another area where blockchain experts' views varied. The companies focused only on making investments that show a proven ROI were content to wait on the sidelines and plan to be fast followers. Others are working on the business-model improvements of peer-to-peer networks that could be unlocked with blockchain. As one interviewee said, "Platforms (Uber, Airbnb, eBay, Lyft, etc.) are algorithms that sit between supply and demand and take 20 percent off the top of each transaction. Peer-to-peer networks are direct transactions. If you need a car and I have one, we find each other in a trusted environment like blockchain. We don't need to pay 20 percent to Uber or Lyft. (If you choose to) sit

on the sidelines for a while until it gets more mature, you're not going to like the position that puts you in. Many business models sit between supply and demand, and when supply and demand can find each other, then they may not need you either at all or as much."

The FOMO (Fear of Missing Out) risk was apparent in several pilot programs for applications that could have been easily accomplished using current, proven technologies. Matching the application to the right technology is a critical consideration. As one expert put it:

- If you want to deploy assets, use a hybrid cloud
- If you have millions of data points that need to be analyzed, use AI
- If you want to share data among supply chain partners, use blockchain

The good news is that companies are still building a blockchain knowledge base. Those still on the sidelines should enter this strategically, not passively, ensuring that they have an organizational capability to adopt blockchain technology when needed. The cautionary statement from a transportation executive was, "People who are only focused on ROI and say, 'Well, if I'm not getting any money out of it, I'm not going to do it, or I'll wait until something comes along,' they are seriously misjudging the impact of peer-to-peer technology."

Why Can't We Be Friends?

The ASCC initiative found the most formidable challenges with blockchain adoption are not technological, but relational. Agreeing on standards, who owns what information, and who has a right to see data under certain circumstances were issues mentioned by many experts. How will they be able to use the information? How will these agreements be enforced?

The answer appears to rely not on where companies differ, but where they can agree. A member of the blockchain in Transport Alliance (BiTA) explained it this way: "Consider two of the biggest pharma companies in the world; under what set of circumstances would the two actually agree to work together? Well, one of those would be that I'm out here in the gray market space or in the counterfeit space chipping away at what you guys are doing. By the two of you working together to implement blockchain in that space, you are forcing one of two things to happen; 1) either forcing me in the gray or the black market to rise to your level, which will create full transparency, or 2) you're forcing me out of that marketplace, to the benefit of both of you."

VALUE CREATION SUCCESSES

The companies interviewed for this report were not able to share hard numbers from their blockchain work either because those numbers had not yet materialized, or they considered that information proprietary. Nonetheless, supply chain leaders saw tangible benefits, which are summarized below.

When we put our blockchain in the cloud and connected all our suppliers, **we were able to get out of the business of DATA COLLECTION and MANIPULATING INFORMATION.**

- **Getting out of the data collection and manipulation business**

  One interviewee said, "For our current applications, we could do everything blockchain does with a plethora of other technologies; it's just under one umbrella with blockchain. When we put our blockchain in the cloud and connected all our suppliers, we were able to get out of the business of data collection and manipulating information." Several companies implementing blockchain applications noted this as a benefit. Another company put it this way: "Every day, there are multiple documents exchanged between (our supply chain partners), including purchase orders, sales orders, delivery/shipment information, goods issues, and goods receipts. This exchange is currently being done via EDI, but there are many issues getting invoices paid."

- **Reducing negotiation time and reconciliation of invoices**

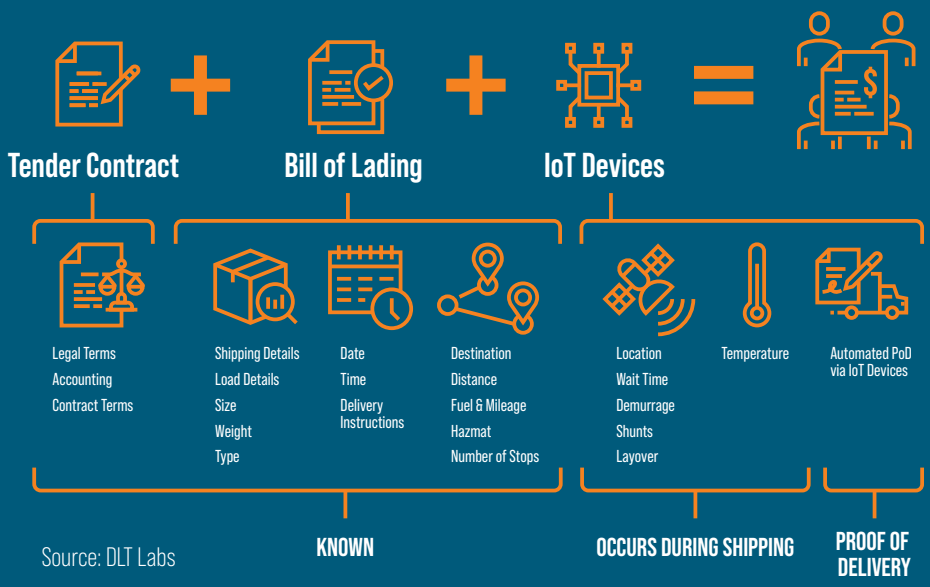
  Resolving invoice disputes not only takes time and money but strains relationships between supply chain partners. An expert at a large technology company maintained, "Without a solution like blockchain, which provides a single, immutable record of what has been agreed to, companies have to engage in long, expensive, and tiring dispute resolutions. [We] have 35 people in procurement that do nothing but solve disputes with suppliers." (See the sidebar, "Walmart Canada and DLT Labs Use Blockchain to Reduce Carrier Invoice Disputes by 97 percent").

WALMART CANADA AND DLT LABS USE BLOCKCHAIN TO REDUCE CARRIER INVOICE DISPUTES BY 97 PERCENT

Paying a third-party carrier invoice for delivered goods on behalf of the company may seem like a pedestrian activity. Supply chain professionals, however, know that it's anything but easy. An individual shipment includes nearly 200 variables from location data and fuel surcharges to tolls, tariffs, and shipment details (see Figure 9). It's estimated that 70 percent of freight contracts are subject to dispute, holding about $140 billion in payments hostage and driving administrative expenses to a staggering 20 percent of transportation costs.

Walmart Canada was feeling that pain. Their operations are connected by a company fleet of 180 tractors and over 2,000 trailers, with roughly 70 other independent providers. Nearly 70 percent of the invoices from the trucking partners had some issue that created a dispute and sent costs north and carrier relationships south. Instead of patching the current process, Walmart made the bold move of changing the process using a blockchain platform from DLT Labs.

Figure 9. One Invoice For Every Load. 200 Data Elements Each.



Louden Owen, CEO of DLT Labs, worked with Walmart Canada to set up a freight payment blockchain for Walmart's third-party trucking companies. He framed the opportunity by saying, "As transportation networks become increasingly interconnected, and products are embedded with computing devices that form the Internet of Things (IoT), an enormous amount of data is being generated that must be managed and integrated. This is particularly challenging inside and among multiple parties in large organizations where the information may be stored and used across different and fragmented operating systems. While the benefits of interconnecting all parties are enormous, managing all the information that is generated can overwhelm legacy information technology systems. Blockchain-based solutions are the answer."[12]

The blockchain platform allows Walmart and its carriers to transact through a shared ledger with high security. The business logic for transactions is captured in smart contracts executed in real time as information is collected from GPS and IoT systems and input into the blockchain. Invoices are paid automatically, and if a discrepancy occurs, it is immediately flagged for correction. According to Owen, "There's nothing to fight over if there is a single source of truth."

The results have been remarkable. With the new blockchain platform, fewer than 2 percent of carrier invoices have resulted in disputes, a 97 percent reduction. One source estimated the immediate savings realized by Walmart at $30 million.[13] Just as important, carrier relations have improved. Walmart Canada is now looking for new ways to leverage blockchain in its operations.

[12] https://www.bloomberg.com/press-releases/2019-11-14/walmart-canada-and-dlt-labs-launch-world-s-largest-full-production-blockchain-solution-for-industrial-application-k2yncz9m
[13] https://www.supplychainbrain.com/articles/32130-walmart-canada-fixing-a-broken-freight-audit-and-payment-process-with-blockchain

- **Reducing liability**

If suppliers are third-party sellers of products for children, they must provide testing reports that the products are safe. Those documents may be scanned in using Optical Character Recognition today, but there is a chance for human error. Why not include this information in the blockchain at the source? A global customs brokerage leader said, "If you marry the physical shipment with the data, you can mitigate risk, [and] set up a secure supply chain. You can talk about provenance, intellectual property rights, valuation. There are a lot of different benefits conferred on the different players, and the only avenue that really gets you there is blockchain. Otherwise, how do you tie it all together?"

Similarly, a subscription model like IBM FoodTrust can operate as an insurance policy. An IBM executive we interviewed explained, "If the Center for Disease Control issues a warning to consumers to not buy romaine lettuce unless you can confirm it is not from the Yuma, AZ growing region, it would be very advantageous to have your insurance policy. You could inform your consumers that your romaine lettuce is OK because you don't source from the Yuma area."

Another instance of reducing liability is allowing suppliers to fill out one template on the blockchain that they control and update. Since this single template can be used on multiple blockchains, it's easy to update, and the information does not go stale. Why is keeping supplier information current important? A large energy company qualified a supplier that subsequently sold part of its business to a Cuban company. Since this energy company only updates supplier information every year, it didn't know that this supplier changed. The company was subsequently fined by the U.S. government for not reporting this change in ownership.

- **Reducing regulatory compliance costs**

In the pharmaceutical industry, it can take about 5,000 hours (208 days) to determine what inventory can be destroyed. Delays like this can cause a company to spend roughly $80M per year on storage and distribution. Having access to the provenance of pharmaceuticals on a blockchain can reduce this unnecessary expense radically.

- **Profit with provenance**

Companies that have implemented provenance solutions have experienced some success. The CIO of a CPG company said, "Traceability and food safety are important to the consumer, and the positive feedback has been astronomical. We've seen incremental sales."

Because of the **TRANSPARENCY** provided by the solution, there is **NO CHANCE** for a **CONSPIRACY THEORY.**

- **Commercial trust**

  Commercial trust was cited as a primary benefit of blockchain, especially concerning payments. Since the calculations have been agreed to by both sides, when the information is fed into the ERP system, it delivers a collaboratively produced, approved invoice. A technology CEO told us, "There are few freight payment disputes, and the ones that do arise are solved quickly." Another blockchain leader said, "because of the transparency provided by the solution, there is no chance for a conspiracy theory." Not only have companies reduced the number of people who worked on disputes, they have also improved their relationships with their supply chain partners.

- **Unexpected benefits**

  While there are always defined metrics for pilots, several firms commented about unexpected benefits that arose from the increased transparency. In one pilot, a company was implementing blockchain to address route compliance. The customer wanted to make sure it was using the correct vendor for shipments. It assumed many shipments were out of compliance because it was the end of the day, and employees just wanted to get the shipments out the door. However, the reason the shipments were out of compliance was because they were putting small parts into big boxes, and the dimensional weight was much larger than the actual weight. The problem was not the people filling the orders, which is what they expected. The problem was they didn't have the right boxes in inventory.

VALUE CREATION HURDLES

A lack of industry STANDARDIZATION is an OBSTACLE to ADOPTION.

Figure 10 highlights the many challenges and limitations associated with implementing blockchain. Let's begin with the elephant in the room, lack of standards. A lack of industry standardization is an obstacle to adoption. Unlike universal product codes (UPCs) and electronic data interchange (EDI), blockchain still has many independent efforts led by various industry stakeholders. This fragmentation is a hindrance to industry standardization, and it is the number one issue limiting blockchain to niche applications, according to blockchain experts. Standards would unlock blockchain nirvana, a network of networks, allowing multiple blockchains in a particular industry to connect.

Interoperability would enable a supplier of leafy greens to have one blockchain that connects not only to Walmart, but Kroger, Publix, and other grocery chains. Speaking to the importance of interoperability, one supplier said, " Suppliers won't join four or five blockchains."

Several consortiums are developing standards for specific industries. Several in the supply chain include:

- **TradeLens:** An ocean freight industry platform developed by Maersk and IBM offering a secure and transparent exchange and record of all transactions for permissioned members. Today, there are more than 100 member companies in the TradeLens ecosystem.
- **Global Shipping Business Network:** An open blockchain platform formed by nine leading ocean carriers and terminal operators. Similar to TradeLens, they are developing an open digital platform based on blockchain technology.
- **The Blockchain in Transportation Alliance (BiTA):** A consortium of nearly 500 members in over 25 countries developing a common framework and standards from which companies in the transportation, logistics, supply chain, and freight markets can build blockchain applications.
- **GS1:** A neutral, non-profit organization in 110 countries developing and maintaining supply chain standards. GS1 released the first version of its standards in January 2020.[14]

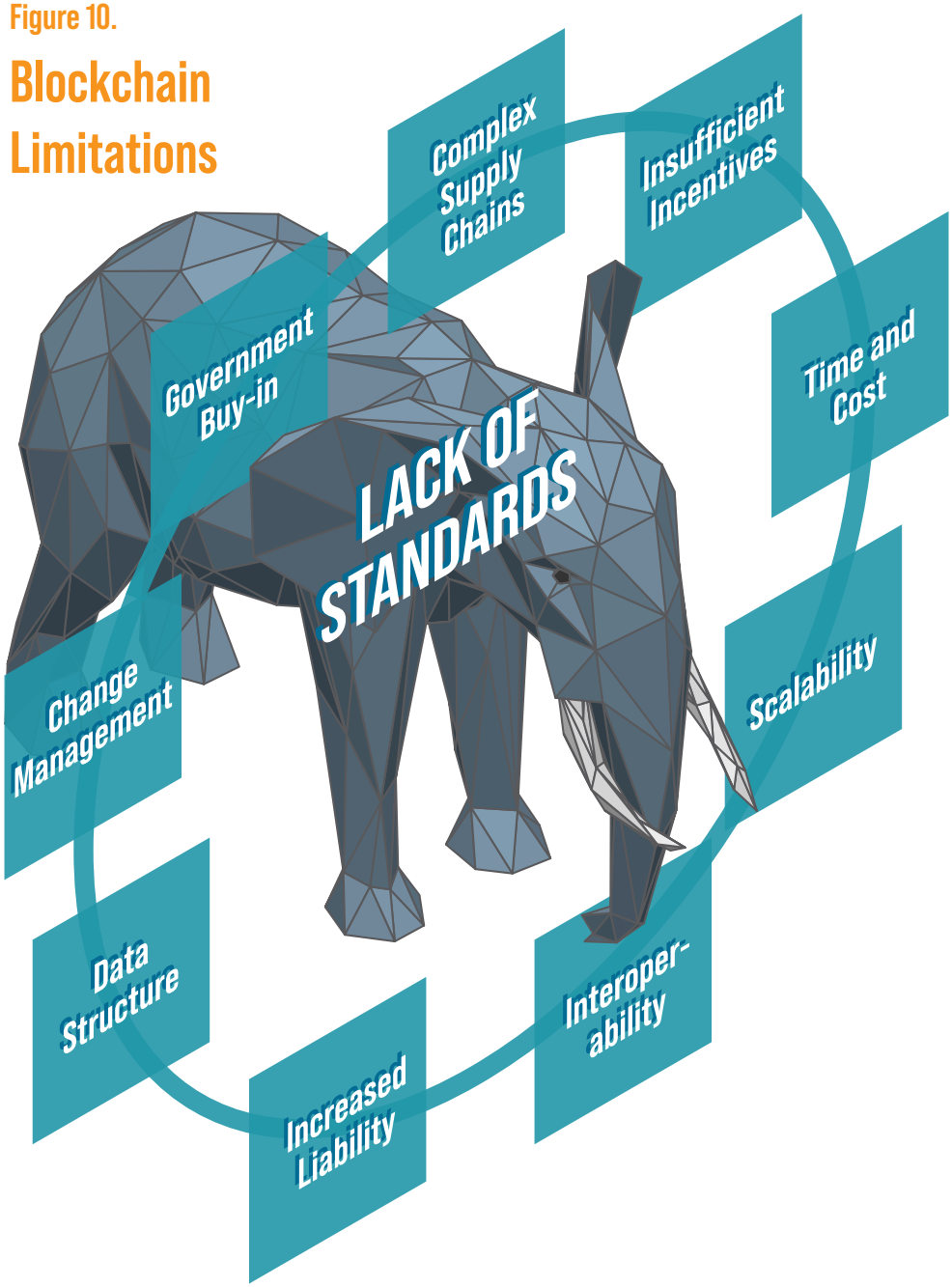
Helping set the blockchain standards for industry is one reason companies spend time and effort with these organizations. A consortium's other critical value is collaboration, allowing members to understand roadblocks early, such as problems with shared data and the need for standards.

[14] https://www.gs1us.org/applying-standards-blockchain-applications

Standard-setting organizations face the classic challenge of rivalry. A European blockchain executive's observation was exemplary: "In Europe, if Carrefour joins a blockchain, other retailers won't join that blockchain." Every industry harbors classic rivalries; Walmart and Target, Coke and Pepsi, Airbus and Boeing, and the list goes on. However, there are signs that companies are beginning to focus on what they can agree on. While UPS and FedEx remain bitter rivals, they are working together with BiTA to develop blockchain standards for the transportation industry.

Figure 10.

Blockchain Limitations



Other limitations outlined by Blockchain experts include:

- **Complex supply chains:** Single-ingredient supply chains like coffee or tuna can track provenance much easier than multi-ingredient supply chains. For example, a Ritz cracker has 15 ingredients. In this case, a cost-benefit analysis may find the minimum viable ecosystem begins at the bakery, not the sources of all 15 ingredients.

- **Insufficient incentives for all supply chain participants:** Whether a firm is creating a private blockchain or participating in another company or consortium blockchain, it costs both time and money. In some cases, the incentives aren't there. For example, a firm working with U.S. Customs and Border Patrol (CBP) is looking for a better ROI through either faster customs clearance or the ability to redirect damaged shipments in transit. Another request was a revenue incentive. A customs brokerage leader from this firm said, "Blockchain secures the transaction, the channel, and even potentially verifying the authenticity of your goods. So, the incentive for CBP is that they don't have to inspect this transaction. How much is CBP saving from not having to do that inspection? Why don't they offer a revenue incentive if you come down this blockchain channel versus the legacy channel?" One blockchain leader summed it up, "The winners will be those that provide the most value to supply chain partners, not themselves."

- **Time and cost:** The cost to set up and maintain a blockchain is an issue, but the time required can be more of a problem according to our blockchain experts. Creating a governance model can answer questions such as, "what's the minimum data quality," "who read and/or wrote permissions," "how will the blockchain be funded and organized," "how to recruit members," and "who will be responsible for maintaining the blockchain," and more?

  These points were echoed by a firm that set up a smart contract with two other companies, which said, "There was certain information that all parties saw, but there was also some private information that was just between two of the parties. Configuring that was difficult."

  Moving beyond a proof of concept (PoC) to full commercialization is an even more significant commitment. An executive experienced in blockchain implementations told us, "The PoC is not a challenge. The real challenge is not the IT transformation; it's the business transformation."

- **Scalability:** Scaling blockchain is the most profound challenge because of the computing power it takes to carry out a transaction. It is said that Bitcoin can only process 4.6 transactions per second. Compare this to Visa, which can process 1,700 transactions per second on average. As blockchains grow their network, transaction speeds could become a huge bottleneck in processing blocks.[15]

The real challenge is not the IT transformation, it's the BUSINESS TRANSFORMATION.

[15] https://towardsdatascience.com/the-blockchain-scalability-problem-the-race-for-visa-like-transaction-speed-5cce48f9d44

How does liability change when EVERYONE HAS ACCESS TO INFORMATION about content?

- **Interoperability:** Interoperability is a significant concern as companies progress from pilot projects to larger networks that involve many more supply chain partners. To reach its potential, blockchain requires end-to-end integration with existing systems, both internal and external. Development to date has primarily focused on private (or permissioned) blockchains that result in disparate platforms without industry standardization. Blockchain is an interdependent solution that needs buy-in from multiple supply chain members to maximize its benefits.

- **Potential increased liability risk:** The Justice Department cited FedEx and UPS for their role in transporting prescription drugs that had been sold illegally. They initially defended themselves by saying they do not know the contents of the packages they ship.[16] How does liability change when everyone has access to information about content? Do all the supply chain members with access to the information about shipments on a blockchain become de facto enforcement agencies?

- **Data structure:** Structuring data to put on a blockchain is a major challenge, and one that needs to be conquered before a company can be successful. Comments from experts include, "That's our shared problem" and "The cost of cleaning up existing data before loading it into a blockchain cannot be underestimated."

- **Change management:** Any time a firm changes a business process, it's not without difficulties. Ask any company that has gone through a SAP implementation. One expert said, "Implementing blockchain is not a technology problem; the problem is social, coordination, getting everyone to agree to use one system, blockchain or otherwise." Another blockchain leader said, "Anybody that says they are scared of process change should not be in the blockchain conversation."

- **Government buy-in:** Government buy-in is one of the major limitations to exponentially increasing the overall use of blockchain technology. Blockchain is a disruption to many processes and systems that governments are built upon. Lobbying this technology's use could take years, making large-scale adoption difficult.

[16] Mundy, A., and Catan, T., "Pain-Pill Probe Targets FedEx, UPS," The Wall Street Journal, November 15, 2012.

BLOCKCHAIN 401: Getting it Done

Building a Blockchain

Motivations to pursue a blockchain solution vary. The most common were to increase visibility and lower administrative costs. A true cost/benefit analysis is out of reach for most companies since most solutions are in pilot versus full commercialization. Organizations are trying to answer a myriad of questions based on their particular context.

- Is the benefit worth the effort?
- Do consumers care about the traceability and transparency associated with goods?
- If so, do they care enough to pay more for the information?

"CONSUMERS are asking for more TRANSPARENCY"

Blockchain solutions that enable tracking food products' provenance to their origin are gaining popularity, and the companies in the food industry claim they are beginning to see financial returns from their efforts. A European blockchain service provider said, "Consumers are asking for more transparency." For example, a company that catches, processes, and sells Fair Trade Certified seafood tracks their fish in a blockchain from the time it is caught to the time it becomes a finished good and is sold to consumers. This information used to be relayed through a mix of automated and manual processes. An executive from the seafood company said, "Now, it's all on the blockchain from the fisher forward. Now, NGOs can look by fisher village, by fisher. (Commercial) buyers never knew how much fish they bought from a particular village. The value proposition is the information up and down the supply chain that helps everyone be more efficient."

Some of the supply chain leaders shared an unexpected motivation: being a good partner. Being part of the blockchain conversation sends a signal to customers, suppliers, and partners that the company is pushing hard to add value through cutting-edge technology. For example, a VP at one of the top small package carriers said, "When there are organization reviews with U.S. Customs and Border Protection, all of our big customers are there. They are looking at whether we're really in this or not. If we're not there, they will penalize us for not keeping up with technology the next time a contract comes around."

Others thought of their blockchain participation as an investment in the industry. Said one, "If you don't look at this strategically, then you could simply say, 'See you in three years.' (However, you would be) missing out on a lot of dialogue, you're missing a lot of learnings, and the people that are trying to advance it will not value your contribution if you're not part of the bumps and bruises."

Getting People on Board: Internal Assessment

Getting other executives on board is about relationship management, not technology. By speaking to colleagues using terms that resonate with them, their role in the organization can be connected to the blockchain project. A Fortune 50 executive we interviewed talked about creating a compelling narrative for the CFO by highlighting a typical benefit of smart contracts, reduction of days sales outstanding. Once the CFO is bought in, then address the CIO, who needs to have people in place that can code smart contracts. Next, the chief legal officer is going to need bilingual attorneys: they're going to need to not only read paper contracts, but also digital smart contracts. By targeting the C suite with persuasive pitches about the business value of blockchain instead of the technology, leaders can substantially improve their project approval rate.

Other supply chain experts cautioned that the internal support for a blockchain project would depend on the business unit. Since blockchain projects require upfront investments, leaders focused on near-term cost reduction will be hard to convince. However, if the leaders are focused on the long-term strategic value of blockchain, a strong case for approval can be made.

Getting People on Board: External Evaluation

Nearly every expert interviewed repeated a similar sentiment: Everyone in the blockchain must have a value proposition to join or don't even bother. A European farm-to-table blockchain set up an e-wallet to incentivize the farmers. A large amount of data is available to farmers to optimize their operations, and they can exchange the e-currency to buy fertilizer, feed, and more. Another organization provides five percent of revenue to farmers for delivering information into the blockchain.

Fisheries on one organization's Fair Trade Certified blockchain provide information because they get paid more for Fair Trade Certified fish. The fisheries must go through audits of labor practices and locations, but because they're getting paid more for the fish, they are providing information on where and how they caught it.

BLOCKCHAIN BEST PRACTICES

While we're still in the early days of blockchain, some lessons have emerged that can help others as they begin or continue their blockchain journey. Figure 11 summarizes the best practices gathered in the ASCC project from supply chain experts who have pursued initiatives to enhance organizational value through blockchain solutions.

Figure 11. Blockchain Best Practices

Involve Business Leaders	· Managing change is the adoptions barrier, not technology · Pilot with the intent to commercialize
Be Agnostic	· These are still the early days of blockchain · Don't lock yourself into one platform
Create Value For All	· Every blockchain participant must have a value proposition · Create a minimum viable ecosystem that ensures value
Be Strategic	· Blockchain implementation should reflect firm strategy · Fear of Missing Out (FOMO) is not a strategy; be strategic
Leverage Unique Blockchain Capabilities	· Pick applications that cannot be done any other way · Distributed database, centralized control, immutable
Wrap Blockchain in Emerging Technologies	· Blockchain gains power working with other technologies · Pursue projects as integrated technology solutions
Be Smart	· Smart contracts unlock blockchain value · Build coalitions on what all can agree on

Source: UT Analysis

The best practices are good lessons learned by blockchain trailblazers in supply chain. But is pursuing a blockchain solution right for your company and industry? Based on both primary and secondary research, Figure 12 represents an initial Blockchain Screener that companies can use to determine if blockchain might be right for them.

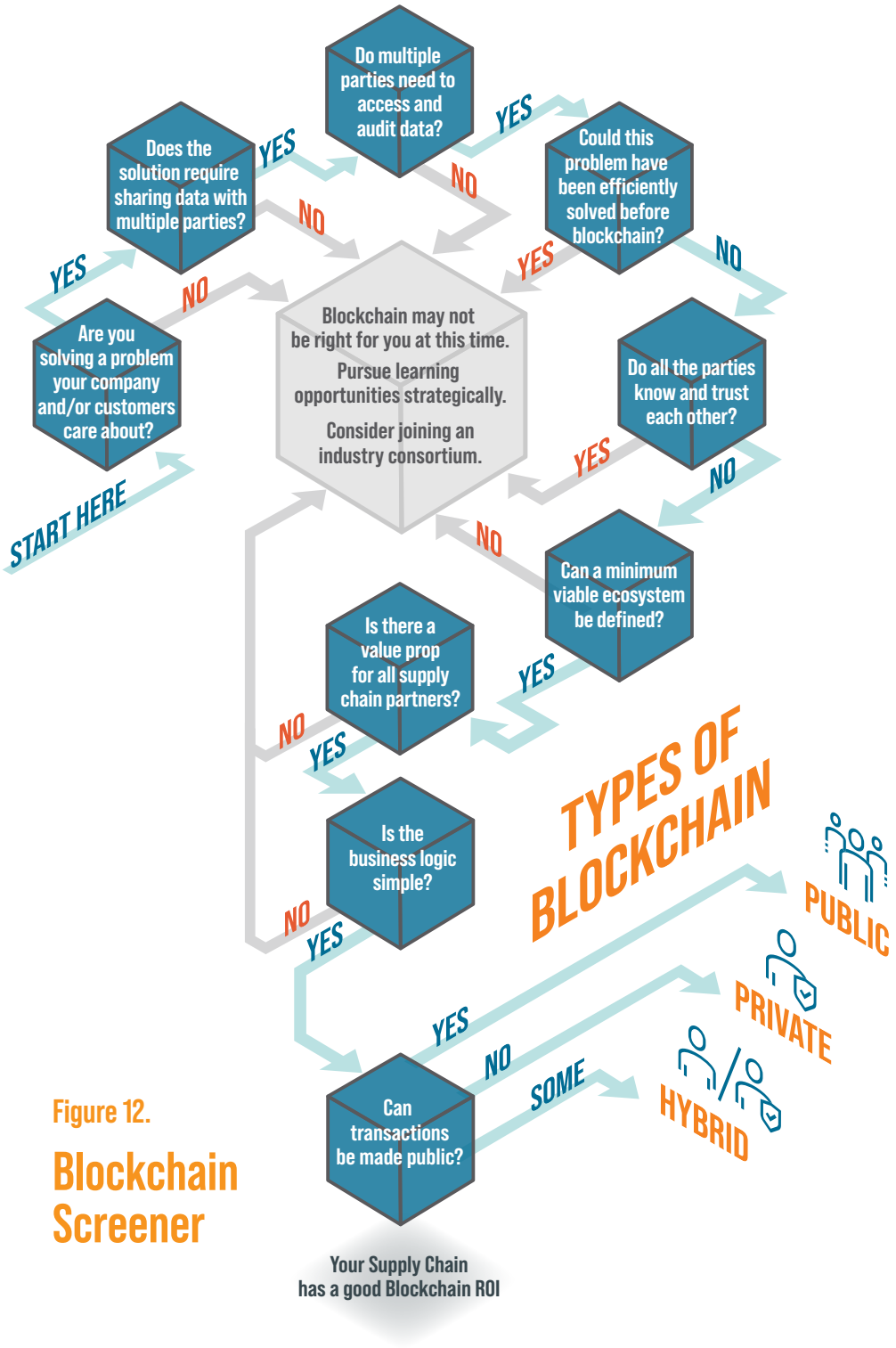


Figure 12.

Blockchain Screener

However, as in most significant advances, there's more to it than initially meets the eye. Further, finding the right answer requires asking the right questions. To that end, this last section outlines a decision-support framework that companies can use to dig into those critical details that can separate success from failure.

DECISION-SUPPORT FRAMEWORK

A fundamental question every organization must ask about blockchain is "SHOULD WE USE IT?"

A fundamental question every organization must ask about Blockchain is, "Should we use it?" Although the matter seems simple, the question hides complexities. So many different factors, technical and social, must be considered. Although we aim to be thorough in this blockchain decision-support framework, it does not include all possible elements that warrant consideration. Instead, we limited our scope to the more pertinent areas executives should think through when considering blockchain.

This is not merely about adopting blockchain, because possessing it without having an appropriate business application for it results in wasted investments and unrealized benefits. Blockchain projects must solve a business' real problems at a cost significantly lower than the benefits.[17] As with any other business investment, executives need to think clearly, deeply, and honestly about whether using blockchain is a sound business decision.

Many blockchain decision models are in circulation. Most of those focus primarily on the technological aspects of blockchain.[18,19,20] They look at aspects of use cases, such as the number of parties that have write access to the database, whether there is trust between the participants, and whether third parties are involved in the process.

Such questions, though valuable, ultimately lead decision makers down the path of specific blockchain architectures. This approach continues to position blockchain largely as an IT affair or initiative.[21] However, blockchain is more akin to a process redesign because it involves most, if not all, aspects of operations, not just IT.[22] Some authorities even say a "Blockchain project for business is 80 percent about business process change; the technology is a small part of it."[23] The process redesign or redefinition can be dramatic, encompassing not just intraorganizational business processes, but also interorganizational business processes.[24]

[17] Mulligan, C., Scott, J. Z., Warren, S., & Rangaswami, J. P. (2018, April). Blockchain beyond the hype: A practical framework for business leaders. In white paper of the World Economic Forum, p.4.

[18] Suichies, B. (2016). "Why Blockchain must die in 2016". Retrieved from https://medium.com/block-chain/why-blockchain-must-die-in-2016-e992774c03b4

[19] Wüst, K. & Gervais, A. (2017). "Do you need a Blockchain?". Cryptology ePrint Archive, Report 2017/375

[20] Meunier, S. (2018). "When do you need blockchain? Decision models". Retrieved from https://medium.com/@sbmeunier/when-do-you-need-blockchain-decision-models-a5c40e7c9ba1

[21] Mougayar, W. (2016). The business blockchain: promise, practice, and application of the next Internet technology. John Wiley & Sons.

[22] ibid.

[23] ibid.

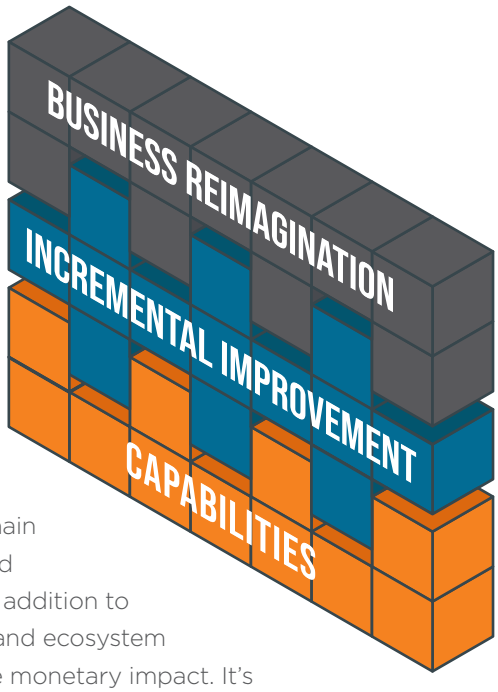
[24] Mulligan, C., Scott, J. Z., Warren, S., & Rangaswami, J. P., op. cit.

As with any technology-related deployment, the business need is the place to start. Unfortunately, what appears to be missing consistently from the abovementioned and other decision models are the appropriate business considerations. [25,26] As a result, it is not uncommon to see organizations start with, if not solely rely on, such techno-centric decision models.

Once organizations have gone through the technology/architecture-centric blockchain decision models and the most appropriate type of blockchain architecture for their organization or use case has been identified, it's time to begin the hard work of making a business decision.

Figure 13.

Building Blocks of The Blockchain Decision-Support Framework



After recovering from all the blockchain tech jargon, consider if this newfound architecture is financially feasible (in addition to assessing regulatory, technological, and ecosystem viability) and likely to have a positive monetary impact. It's important to be comprehensive in the blockchain business value assessment and not fall into the trap of thinking solely about the operational benefits. So, when trying to determine and hone in on blockchain's ROI and whether to move forward with it, organizations should consider three domains: capabilities, incremental improvement, and business reimagination (see Figure 13). Within each domain in Figure 13 are several thematic elements that capture the essence of the questions posed in the decision framework.

The **Capabilities Domain** focuses on depicting the economic impact of developing and deploying key value drivers, such as trust, transparency and visibility, data integrity and consistency, and the infrastructure that supports leveraging those capabilities. This dimension is fundamental for any organization considering blockchain. It should not be glossed over to reach the eye candy in another category. The capabilities domain serves as a pillar of stability during the pursuit of value from blockchain.

[25] Koens, T. & Poll, E. (2018). "What Blockchain Alternative Do You Need?" in Proceedings of the 2nd International Workshop on Cryptocurrencies and Blockchain Technology (CBT), Barcelona, Spain.

[26] Betzwieser, B., Franzbonenkamp, S., Riasanow, T., Böhm, M., Kienegger, H., & Krcmar, H. (2019). "A decision model for the implementation of blockchain solutions", in Proceedings of the Twenty-fifth Americas Conference on Information Systems, Cancun.

The **Incremental Improvement Domain** focuses on driving home three key points for organizations to consider and assess. One point is the need to identify and focus on problems and pain points that can be and must be solved/addressed right now. Another goal is improving labor efficiency by reducing the non-value-added tasks personnel must perform because of archaic or poorly designed processes. The third objective is viewing the solution portfolio holistically to address both current and longer-term pain points. The key is that blockchain should be considered part of the solution portfolio and not the all-encompassing solution.

The third, and final, domain is the **Business Reimagination Domain**. It focuses on the more strategic areas of the business and where value could be realized from applying blockchain. The strategic value areas included in the framework are employee value proposition, customer experience, augmenting customer value derived from product interaction or consumption, identifying and deploying new products and services, and creating new business models to move the organization forward and increase its competitiveness in the marketplace.

To help with the assessment, Figure 14 presents 15 key questions organizations should consider and strive to answer before committing to blockchain implementation (see Appendix I). Notice that no default weights are assigned to the thematic areas; each organization should have the flexibility to adjust these weights as it sees fit. Also note that certain domains contain more thematic questions than others. Though these might imply areas more heavily weighted than others, do not to fall into that mindset. It could be that domains with fewer thematic areas and questions have a greater impact on the organization than those covering more thematic areas and questions.

The domains described above are portrayed in Figure 14.

Figure 14. Framework Domains and Thematic Elements

DOMAIN	THEMATIC AREA
Business Reimagination	New Business Model(s)
	New Business Products and Services
	Customer Experience/Product Consumption
	Employee Value Proposition
Incremental Improvement	Current Pain Points
	Why Not Ask Why? Labor Efficiency
	Solution Portfolio
Capabilities	Trust
	Transparency and Visibility
	Data Integrity and Consistency
	Data Sharing
	System Integration and Interfacing

CHALLENGES AND ISSUES

With any new technology comes challenges. Hesitating to implement because of uncertain ROI analyses likely will be the largest hurdle in the next five years. The large CPG and pharmaceutical companies interviewed for this research have implemented blockchain technology with the help of executive leadership buy-in. Although monetary measures may not come to fruition in the near term, these companies believe being an early adopter will pay off in the long term. Lack of use cases that have successfully implemented end-to-end blockchains hinders measuring its profitability.

The complexity of implementing blockchain with existing technologies such as ERP, IoT, barcoding, RFID, supply and operations planning software, and others may feel daunting. Blockchain is not a technology to replace existing systems, but to work in tandem with these systems. Whether a company should designate a team to implement blockchain and who should lead it can be hard to decipher. Blockchain technology may fall within the information technology department for maintenance and technology implementation. However, it is in the firm's best interest first to understand the business strategy fully. Designating a blockchain team that encompasses information technology professionals, operations experts, and leadership will ease the frustration of long-term implementation challenges to ensure that all systems used in a firm can coexist.

Many of the supply chain leaders called the promise of interoperability between blockchains a game changer. For example, one of the interviewees said, "The big win on the horizon is 'network of networks,' when (we) can start integrating our blockchain with other private and public blockchains." An executive at one of the blockchain consortiums explained, "Our default position is essentially the International Space Station; data knows no geographic boundaries. What we're really talking about is a true open-source model. Think of Linux Foundation or something along those lines. I've got a Samsung phone that's got an Android open-source platform. We can decide to build an app on top of that and sell it, but the platform itself is truly open source."

Where will future enduring value be created with blockchain? We see several key themes emerging:

- **Applications will rule:** One executive told us, "Blockchain is going to be a foundational protocol layer, but that's not where the winners and losers will be. We think the winners and losers will actually be at the app layer." Another leader whose company has developed a blockchain platform indicated that they are also focused on developing apps and encouraging third parties to build apps on their platform. If blockchain follows the path of other open platforms like Android and iOS, then every new application potentially creates exponential value.

The REAL WIN
is not in recreating current processes
on blockchain but **CREATING**
entirely new processes
that were not viable using
previous technology.

- **New processes and business models:** A global transportation interviewee captured the aspiration of many companies when he said, "The real win is not in recreating current processes on blockchain but creating entirely new processes that were not viable using previous technology." "Supply chain blockchain projects have mostly focused on verifying authenticity, improving traceability and visibility, and improving transactional trust," said Alex Pradhan, senior principal research analyst at Gartner. "However, most have remained pilot projects due to a combination of technology immaturity, lack of standards, overly ambitious scope, and a misunderstanding of how blockchain could, or should, actually help the supply chain."[27]

  Another forward-leaning executive presented the blockchain opportunity in the form of a question: "What are some universal challenges to sharing information between business partners that blockchain can help solve? 1) How to build trust between business partners? 2) How to equitably share benefits?"

- **The democratization of access and trust:** "The power is building (distributed) applications that can serve multiple purposes." This statement captures the disruptive nature of blockchain. But is blockchain a disruptive technology? Clayton Christensen defined sustaining innovations as those that seek to improve existing products. Today, most applications of blockchain are sustaining innovations (e.g., track and trace, provenance, payment processing, managing IoT networks, medical record sharing, smart contracts, digital content distribution). If blockchain is a disruptive technology, it's potentially being applied incorrectly. "If, as most successful companies try to do, a company stretches or forces a disruptive technology to fit the needs of current, mainstream customers…it is almost sure to fail."[28]

  If blockchain is applied to the wrong application, the real ROI of blockchain will not be uncovered. It also supports the contention of several blockchain experts that, while blockchain has not proven to be a silver bullet, it should be pursued strategically.

[27] Gartner Predicts 90% of Blockchain-Based Supply Chain Initiatives Will Suffer 'Blockchain Fatigue' by 2023, https://www.gartner.com/en/newsroom/press-releases/2019-05-07-gartner-predicts-90--of-blockchain-based-supply-chain

[28] Christensen, C. M. (2013). The innovator's dilemma: when new technologies cause great firms to fail. Harvard Business Review Press, Page 226.

CONCLUSION

CONDUCT PILOTS with an intent to COMMERCIALIZE, involving both business and technology professionals in your organization.

If we did our job in this white paper, the next time someone mentions "blockchain" in a meeting, you'll be rubbing your chin instead of rolling your eyes. As supply chains become more distributed, coordinating the end-to-end flow of information, goods, and funds will grow more challenging. More partners, more data, more headaches. If your company is dealing with these issues, we believe blockchain should be considered as a key part of your solution set.

Until industry standards are set, the ROI will come from industrial applications in private, permissioned blockchains allowing a network of partners to collaborate and transact on a shared and secure platform. Additional value can be unlocked by integrating blockchain with other Industry 4.0 technologies such as IoT and AI. Conduct pilots with an intent to commercialize, involving both business and technology professionals in your organization.

You're now ready to "cross the jungle" between blockchain theory and implementation. Use the Blockchain Screener along with the 15 questions in the Decision-Support Framework to map out blockchain opportunities with your colleagues. Before you know it, you too will have created a path through the jungle that can be easily followed!

APPENDIX

Key Questions to Help Determine Your Blockchain ROI

1. What financial implications have manifested because of operating in an environment predicated upon trust between trading partners? We can all agree that trust is at the heart of a complex global supply chain. But what are we willing to pay not to have to worry about trusting stakeholders and trading partners? What level of distrust, and with whom, is an acceptable level of distrust not detrimental to business relationships? Trust is fundamental, but each organization will have to determine how much trust is "enough" trust.

2. If you had a clear and compelling reason for operating in a system that doesn't require trust, how would you benefit (or be negatively affected) financially? Evaporation of trust is directly damaging for economic growth at multiple levels.[29] As such, some organizations perceive the ability to participate in a network built on trusting (or where there is no need to explicitly trust) trading partners and affiliates to avoid trust evaporation is worth it. But what does "worth it" mean? To answer that question, calculate the relationship management costs and benefits. You must be able to quantify the cost of relationship management under trust and distrust. This will help you determine if business relationships with no or low trust are more expensive to manage and maintain relative to those with high trust requirements.

3. What's the economic value of (full) transparency among trading partners? Transparency has been touted as a value driver of blockchain.[30] One challenge with transparency is invoicing. There are numerous ways lack of transparency or low transparency results in negative economic value. Some include mismanaging or incorrectly paying an invoice, rate changes, and inaccurate rates or calculations being used for an invoice.

4. How much will it cost you to create infrastructure that promotes transparency? Again, transparency can be promoted, but not necessarily demanded. Perhaps what most people mean when they say "transparency" in a blockchain context is "visibility." Transparency depends on the willingness and capabilities of one trade partner to be open and forthright when participating in the ecosystem. This goes back to the need for trust among trading partners. Each organization must determine which is more important. Beyond a willingness of both internal and external partners to be transparent is the ability to do so. You cannot share what you don't know and can't see. Whereas some organizations may already have the infrastructure in place to enable them to be transparent, others do not. So, take a sober estimate of what your transparency capabilities are now and what is needed to develop or improve them.

[29] Coyle, D. (2013). The cost of mistrust. OECD Yearbook. Retrieved from http://www.oecd.org/forum/the-cost-of-mistrust.htm.

[30] Warren, S., Deshmukh, S., Whitehouse, S., Treat, D., Worley, A., Herzig, J., ... & Nolting, G. (2019). Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits. World Economic Forum.

5. Can you place a value on data integrity? Whether you can or not, you must be able to determine the cost of trying to achieve data integrity.[31] Blockchain doesn't make all your information management challenges go away. Those issues still need to be addressed, so be prepared to assess the cost of liberating data you would consider placing on the chain. Remember to factor in any use of external services/ personnel to gather, synthesize, and store data.

6. Related to, but somewhat distinct from, the previous decision is the question of whether you can quantify (from an economic standpoint) the cost or benefit of avoiding data inconsistencies and improved and streamlined data maintenance. The more channels and input points you have across your organization, the more likely it is that you will experience data inconsistency. Organizations still suffer from information fragmentation, and that does not bode well for using blockchain. Data inconsistency is not always the result of data silos and technical snafus. It can also be attributed to a lack of consensus throughout the organization on the meaning of specific business.

7. What percentage, and which, of your data assets need to be shared and maintained across a consortium of organizations or needs a high degree of accuracy? Even if your percentage of data assets that must be shared is relatively low, its value or importance could be high. That's why it's important to identify those data assets and generalize them as "supply chain data," for example.

8. Is the primary focus on developing and deploying transformative business models or making existing processes more efficient? Improving process efficiency and reducing operating costs are good in theory, but they're not necessarily going to yield an ROI worth talking about. This still may be acceptable in the short term, but sights should be set on creating transformative business models.[32,33]

9. What problems can blockchain help me address or solve for my stakeholder right now? It's great to be forward thinking, but stakeholders must first generate value in the short term before getting to the "blue sky" state of mind. Have a longer-term plan for leveraging blockchain, but don't ignore the fact that your fellow business leaders may not be as patient as you are for ROI to manifest.

10. Do rules governing transactions change frequently enough that such changes create an undue burden on your personnel, resulting in labor hours expended on non-value-added activities, such as reconciling transactions and related disputes with trading partners? If so, it's time to ask yourself:

a. Why are those rules constantly changing?
b. Where is the economic improvement from those rule changes or the financial detriment associated with the rules not changing?
c. How much control do you have over when and how those rules must change?

[31] Not all trading partners will have the same definition of data integrity, so you will need to engage ecosystem members in this conversation to reach an agreed-upon, consistent meaning of data integrity.

[32] Risius, M. & Spohrer, K. (2017). A blockchain research framework. Business & Information Systems Engineering, 59(6), 385-409.

[33] Etwaru, R. (2018). Blockchain: The Audacity To Break Into A New Economic Period, Presented at 2018 MHI Executive Summit, Orlando, FL. Retrieved from https://www.mhi.org/conference2018/downloads/slides/290.pdf

11. What percentage of the problem/opportunity you're addressing is accounted for by the proposed blockchain? Blockchain is more likely to be part of the overall solution rather than the solution, so it's important to quantify the level of contribution to better ascertain its ROI.

12. What are the costs associated with achieving the necessary level of integration between blockchain and your existing systems and IoT devices to ensure access to the blockchain and facilitate the flow of on-chain and off-chain data? Often, the level of integration needed requires developing interfaces, and this can be more challenging and costly if you require or desire to integrate data from legacy systems.[34]

13. What new business products and services does it allow you to offer and what's the potential market value and interest in them? It's quite interesting that many leaders are not starting with this thought process. In fact, the primary focus for organizations is on improving existing products and services before considering new opportunities.[35] We recognize that such issues may not be viable in the early stages of your blockchain endeavors, but you still should consider them in the early stages of your business evaluation of blockchain.

14. Can blockchain help me improve customer experience and product/service interaction, and what's the economic impact of improving such metrics? Organizations that embody a customer experience mindset drive revenue 4-8 percent higher than competitors in the same industry.[36] Further, 96 percent of customers say customer service is important in their choice of loyalty to a brand, and loyal customers are five times more likely to be repeat purchasers and four times more likely to act as influencers on the brand's behalf.[37]

15. How does blockchain's use improve our employee value proposition? As more organizations continue to cite the difficulty of finding qualified supply chain talent as a top challenge,[38] could your organization innovatively embracing blockchain help you offer a compelling answer to the question, "Why would a highly talented person choose to work here?"[39] According to the 2020 MHI Annual Industry Report, solutions to workforce challenges will require building and maintaining a culture of innovation and technology within the organization. This is based on the belief that talent and technology are linked fundamentally together in the success of digital supply chains. [40]

The rationale behind these 15 questions is that blockchain is another method to manage and share data. The goal is to be able to determine the value and costs associated with creating a system of processes to ensure data representing products and services involved in transactions – from cradle to grave and point of origin to consumption – can be shared by network partners easily and as close to real time as needed.

[34] Beck, R., Stenum Czepluch, J., Lollike, N., & Malone, S. (2016). Blockchain –the gateway to trust-free cryptographic transactions. Proceedings of the 2016 European Conference on Information Systems, Istanbul, Turkey.

[35] Mulligan, C., Scott, J. Z., Warren, S., & Rangaswami, J. P. (2018, April). Blockchain beyond the hype: A practical framework for business leaders. In white paper of the World Economic Forum.

[36] Morgan, B. (2019, September). 50 Stats That Prove The Value Of Customer Experience. Forbes. Retrieved from https://www.forbes.com/sites/blakemorgan/2019/09/24/50-stats-that-prove-the-value-of-customer-experience/#522892094ef2.

[37] Ibid.

[38] Material Handling Institute. (2020). Embracing the Digital Mindset: Connecting Data, Talent, and Technology in Digital Supply Chains. MHI Annual Industry Report.

[39] Michaels, E., Handfield-Jones, H., & Axelrod, B. (2001). The war for talent. Harvard Business Press.

[40] Material Handling Institute. op. cit.

Blockchain Best Practices

Involve Business Leaders	· Managing change is the adoptions barrier, not technology · Pilot with the intent to commercialize
Be Agnostic	· These are still the early days of blockchain · Don't lock yourself into one platform
Create Value For All	· Every blockchain participant must have a value proposition · Create a minimum viable ecosystem that ensures value
Be Strategic	· Blockchain implementation should reflect firm strategy · Fear of Missing Out (FOMO) is not a strategy; be strategic
Leverage Unique Blockchain Capabilities	· Pick applications that cannot be done any other way · Distributed database, centralized control, immutable
Wrap Blockchain in Emerging Technologies	· Blockchain gains power working with other technologies · Pursue projects as integrated technology solutions
Be Smart	· Smart contracts unlock blockchain value · Build coalitions on what all can agree on

Source: UT Analysis

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