Making Sense of Blockchain
How Firms Can Chart a Strategic Path Forward

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How Firms Can Chart a Strategic Path Forward

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Introduction

Blockchain has been hailed as the biggest breakthrough since the internet. Its potential benefits span industries, and many companies today are actively considering adopting it to explore its transformative potential. How should firms approach such a promising but risky new technology?

The technology is often confused with Bitcoin, but its applications extend far beyond cryptocurrencies. Blockchain can pave the way to a reconfigured world in which banks, insurers, utilities, retail firms, media companies, hospitals, and law firms all communicate with one another effortlessly. In a world with widespread blockchain adoption, business models would change drastically: Utility firms would arrive on maintenance calls because customers' smart home systems had triggered service delivery and already contacted the insurer and bank for payments. Retailers shipping products from remote villages across continents would clear border security and customs checkpoints in seconds, tracking the process every step of the way. Pharmaceutical companies would more easily trace drug ingredients to their source, vastly reducing the incidence of the counterfeit medicines that plague today's supply chain.

Using blockchain, media streaming firms could track content usage with precision. Even little-known artists would receive royalties accurately and instantly. Copyrights of all types of art could be traced and intellectual property rights enforced globally.

> Despite these exciting possibilities, it is not always obvious whether a particular company should adopt blockchain.

Software service firms would have access to customers' digital identities, enabling a holistic view of their service needs. Hospitals, too, would have a secure and comprehensive view of patients' health, medication, and lifestyle, just as banks would of customers' financial affairs. Each firm, regardless of its size, would be able to capture a holistic picture of customer needs and customize its services at an individual level.

Hospitals could deliver precision treatments since smart wearables would monitor patient health and communicate necessary stats to doctors. Pharmaceutical companies could develop more drugs for orphan diseases because they'd have access to sufficient patient samples from across the world upon which to perform research.

Banks would not only make payments across international borders in seconds, but also automatically file taxes and manage customers' wealth. They'd communicate with foreign banks and provide visibility into necessary documentation and sources of funds, making financial transactions globally accessible.

Energy distribution would change with peer-to-peer energy exchanges and smart grids that widen revenue streams. Governments could make financial inclusion a reality and manage welfare programs effectively with tamper-proof digital identities. Increased transparency in government services, welfare payments, and voting could substantially decrease opportunities for corruption.

Overall, blockchain enthusiasts envision a seamless world of digitized transactions. The technology's anticipated business value ($3 trillion by 2030) and projected annual cost savings ($2-6 billion) make it one of the most potentially transformative technologies on the horizon.[1]

Despite these exciting possibilities, it is not always obvious whether a particular company should adopt blockchain, or when and how it should go about it. Technology-driven companies do often succeed at outpacing competitors, but the right firm capabilities and market timing are critical for success.[2] Therefore, managers should exercise caution before committing. It is crucial to carefully analyze the firm's need for blockchain, its anticipated value, and the firm's capabilities before investing in the technology.

To cut through the noise surrounding blockchain, the Mack Institute has studied firms, spoken to leading practitioners, and laid out the following road map to help companies make informed decisions. This white paper examines four key questions that managers should consider as they work through whether their firm should adopt blockchain, how it might impact their business, and the strategic choices for implementation.

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1   Melanie Swan, *Blockchain: Blueprint for a New Economy* (Sebastopol, CA: O'Reilly Media, Inc., 2015).
Anna Irrera and Jemima Kelly, "Blockchain could save investment banks up to $12 billion a year: Accenture," *Reuters,* January 17, 2017, https://www.reuters.com/article/us-banks-blockchain-accenture/blockchain-could-save-investment-banks-up-to-12-billion-a-year-accenture-idUSKBN1511OU.
Gartner, Inc., "Gartner Reveals Top Predictions for IT Organizations and Users in 2017 and Beyond," press release, October 18, 2016, https://www.gartner.com/newsroom/id/3482117.
Matt Turner, "A 'game changer' technology on Wall Street could shake up stock trading," *Business Insider,* May 25, 2016, http://www.businessinsider.com/goldman-sachs-blockchain-cash-equities-trading-2016-5.
Oscar Williams, "Santander is experimenting with bitcoin and close to investing in a blockchain startup," *Business Insider,* June 17, 2015, http://www.businessinsider.com/santander-has-20-25-use-cases-for-bitcoins-blockchain-technology-everyday-banking-2015-6.

2   Michael Sadowski and Aaron Roth, "Technology Leadership can Pay Off," *Research-Technology Management* 42, no. 3 (1999): 32-33, doi:10.1080/08956308.1999.11671315.

The Power of Blockchain

Blockchain's properties can make existing processes more efficient while providing new solutions to pressing problems.[3] At its core, blockchain is a shared ledger that is transparent to all parties and is (almost) unalterable. This kind of visibility creates trust among participants, paving the way to business model transformation.

On a blockchain, transactions take place over a peer-to-peer computer network. Each transaction's data is recorded in a hash-coded "block." Every subsequent transaction is sent to the network, validated, then encoded in a new block along with all the previous hash codes. The blocks of data provide a continuous record (the "chain" of blocks for which the technology is named), so a user can trace previous transactions all the way back to the first one. Since all the data-blocks are linked, data become nearly impossible to change and all parties on the network can trust the data's authenticity.

The ability to create extensive, tamper-proof data records opens up powerful opportunities. Crédit Mutuel Arkéa Bank of France, for example, has created an internally-shared Know-Your-Customer (KYC) platform which allows employees at every function of the bank to access the entire history of a customer's KYC documentation.[4] Six banks in Canada are attempting an industry-level solution to decentralize and share digital identities externally across

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3   FinTech Network, *Four Blockchain Use Cases for Banks,* http://blockchainapac.fintecnet.com/uploads/2/4/3/8/24384857/fintech_blockchain_report_v3.pdf.
Jesse Groenewegen, Marijn Heijmerikx and Jurriaan Kalf, *The Impact of Blockchain on Trade Finance* (Netherlands: Rabobank, November 13, 2017), https://economics.rabobank.com/publications/2017/november/the-impact-of-blockchain-on-trade-finance/.
Jo Lang, "Three uses for blockchain in banking," *IBM* (blog), October 23, 2017, https://www.ibm.com/blogs/blockchain/2017/10/three-uses-for-blockchain-in-banking/.
Deloitte, "Blockchain Applications in Banking," *Deloitte,* 2016, https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/innovation/ch-en-innovation-deloitte-blockchain-app-in-banking.pdf.

4   Catherine Palmer, "Crédit Mutuel Arkéa breaks new ground in France with blockchain," *IBM* (blog), February 6, 2017, https://www.ibm.com/blogs/cloud-computing/2017/02/06/credit-mutuel-arkea-blockchain/.

banks, insurers, utility providers, etc. This move would provide stakeholders with access to authentic real-time data on customers, delivering a holistic picture of customer finances.

Apart from providing process and cost efficiencies, blockchain can transform automatic triggering and delivery of financial services. Blockchain allows the terms of a contract to be encoded on the application so that only transac-

> Blockchain's transparency creates trust among participants, paving the way to business model transformation.

tions in compliance with those terms can be recorded. These smart contracts encapsulate all the rules of interaction among participants in the blockchain network. Information such as terms of operations between participants, their rights, consensus requirements, product and pricing information, and so forth are written into the code, allowing transactions to be executed automatically without the need of a verifying body.

When smart contracts are paired with shared proofs of identity, then verification and authentication of transactions can become fully automated. For example, ST Aerospace has piloted a blockchain-based 3D-printing solution that verifies design purchases from the U.S. as genuine and from the right source.[5] Digital rights management makes the design file tamper-proof. Smart contracts identify the right materials and printing techniques, then immediately trigger printing on a 3D printer in ST's Singapore facilities using its laser metal process. Similarly, the Federal Aviation Administration and other aviation agencies have a critical need to establish the provenance of aircraft parts. By digitizing this tracing process in a tamper-proof way, these agencies can save cost and time while ensuring better quality.

Nasdaq has launched its own payment platform that verifies and executes trading transactions based on smart contracts. The platform also automates

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5   Agam Shah, "Trust in the Supply Chain," *Mechanical Engineering Magazine*, May 2018, 30-35.

streamlined payments, liquidity readjustments, and reconciliations based on real-time data and embedded trading rules.[6] Such payment platforms can eliminate financial intermediaries like clearinghouses and money transfer firms that charge high transaction fees (especially for international transactions).

The disintermediation that blockchain provides can render transactions in the insurance sector more transparent, reduce moral hazard, verify claims, and reduce transaction disputes.[7] Similarly, verification of the authenticity and validity of government records, land titles, and notary services can be automated so that their accessibility is improved and their management is made vastly more efficient.[8]

Every transaction record on a blockchain is time-stamped. When time-stamping is combined with hash functions and smart contracts that build consensus mechanisms for recording data, supply chain controls change dramatically.[9] Danish shipping firm Maersk is creating a global shipping container platform.[10] When a shipment container arrives at the U.S. border, the Department of Homeland Security can view the shipment's entire history. Inspectors can see who has handled it, in what condition, at what time, and whether customs

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6   Nasdaq, "Nasdaq and Citi Announce Pioneering Blockchain and Global Banking Integration," news release, May 22, 2017, https://www.nasdaq.com/article/nasdaq-and-citi-announce-pioneering-block-chain-and-global-banking-integration-cm792544.
Jordan French, "Nasdaq Exec: Exchange Is 'All-In' on Using Blockchain Technology," *The Street*, April 23, 2018, https://www.thestreet.com/investing/nasdaq-all-in-on-blockchain-technology-14551134.

7   Suzanne Barlyn, "AIG teams with IBM to use blockchain for 'smart' insurance policy," *Reuters*, June 14, 2017, https://www.reuters.com/article/us-aig-blockchain-insurance/aig-teams-with-ibm-to-use-block-chain-for-smart-insurance-policy-idUSKBN1953CD.

8   Buck B. Endemann and Benjamin L. Tejblum, "Blockchain Energizer – Volume 21," *National Law Review,* February 1, 2018, https://www.natlawreview.com/article/blockchain-energizer-volume-21.

9   KPMG and Macquarie Graduate School of Management, *Supply Chain Big Data Series,* part 4 (June 2017), https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/disruptive-technologies-sup-ply-chain-future.pdf.

10   David Z. Morris, "Maersk Tests Blockchain-Based Freight Tracking," *Fortune,* March 5, 2017, http://fortune.com/2017/03/05/maersk-tests-blockchain-based-freight-tracking/.

has verified the container's regularity. If all checks are satisfied, Homeland Security can immediately record its acceptance.

Hash functions and time-stamps establish the reliability of data, and hence the provenance of goods, while obviating the need for third-party verification. Walmart is tracking perishables such as pork and mangoes to leverage these gains; Provenance Ltd. is tracking seafood; Pfizer, medicines; and De Beers, diamonds.[11] ■

Seven Strategic Challenges

Great potential often comes with great challenges, and managers must clear many hurdles before they can begin to realize blockchain's promise. Business challenges such as cost of entry, financial implications, infrastructure, talent, risk appetite, and privacy make its adoption difficult. Before moving forward, firms must consider the following:

1) GAUGING THE ACTUAL IMPACT

The foremost hurdle for a firm is to accurately evaluate the impact of implementing a blockchain solution. The firm should thoroughly understand not only its own value chain but those of its stakeholders to determine where to intervene. The firm will also have to assess efficiency savings

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11   Richa Naidu and Anna Irrera, "Nestle, Unilever, Tyson and others team with IBM on blockchain," *Reuters,* August 22, 2017, https://www.reuters.com/article/us-ibm-retailers-blockchain/nestle-unilever-tyson-and-others-team-with-ibm-on-blockchain-idUSKCN1B21B1.
CB Insights, *Blockchain Investment Trends in Review* (November 2017), https://www.cbinsights.com/research/report/blockchain-trends-opportunities/.
Arvind Krishna, "The Power of blockchain + Watson," *IBM* (blog), May 22, 2017, https://www.ibm.com/blogs/research/2017/05/power-blockchain-watson/.
Robert Hackett, "Walmart and 9 Food Giants Team Up on IBM Blockchain Plans," *Fortune,* August 22, 2017, http://fortune.com/2017/08/22/walmart-blockchain-ibm-food-nestle-unilever-tyson-dole/.
CB Insights, *How Blockchain Could Transform Food Safety* (December 13, 2017), https://www.cbinsights.com/research/blockchain-grocery-supply-chain/.

for its stakeholders, then align their interests to secure cooperation on a proposed solution.

2) Derailing Traditional Revenue Sources

Blockchain is likely to disrupt the revenues of businesses that connect stakeholders or create credibility and trust for them.[12] Examples include retailers such as Google Express and Amazon that connect buyers and sellers, banks that provide escrow services and currency swaps, and law firms and notaries that provide trust services. Smart grids will displace today's centralized energy distribution business models, allowing peer-to-peer electricity and alternate energy trading.[13] Resistance to commercializing blockchain is hence to be expected from such firms.

3) Updating Infrastructure

Integrating legacy systems with new technology can present a daunting challenge. The Quartz crisis of the 1970s offers a well-known example: Swiss watchmakers refused to switch from their legacy mechanical watches to electronic watches even as competitors were evolving.[14] When it comes to blockchain, updating infrastructure is currently cost-prohibitive and risky. In addition to initial capital expenditure, firms will face capital losses from discarding legacy infrastructure. Operational expenses

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12   Knowledge@Wharton, "Is blockchain the next great hope – or hype?," *Knowledge@Wharton,* January 11, 2017, http://knowledge.wharton.upenn.edu/article/blockchain-next-great-hope-hype/.

13   Mike Orcutt, "How Blockchain Could Give Us a Smarter Energy Grid," *MIT Technology Review,* October 16, 2017, https://www.technologyreview.com/s/609077/how-blockchain-could-give-us-a-smarter-energy-grid/.

14   Michael J. Enright, "Organization and Coordination in Geographically Concentrated Industries," in *Coordination and Information: Historical Perspectives on the Organization of Enterprise,* ed. Naomi R. Lamoreaux and Daniel M. G. Raff (National Bureau of Economic Research, January 1995), 133-140, http://www.nber.org/chapters/c8751.
Joe Thompson, "A Concise History of the Quartz Watch Revolution: In the watch world, the 1970s changed everything," *Bloomberg,* November 16, 2017, https://www.bloomberg.com/news/articles/2017-11-16/a-concise-history-of-the-quartz-watch-revolution.

will be substantial, with high costs for implementation and continuous upgrades to support the massive scale required.

4) Standards & Dominant Designs

The lack of standards for implementing blockchain makes it risky for incumbents to invest in the technology. Bodies like Standards Australia and Electronic Industry Standards Research Institute of China are developing standards, while consortiums such as Enterprise Ethereum Alliance, R3, and Hyperledger are working towards effective and efficient business solutions.[15] But because the technology is still immature, dominant designs will continue to evolve for some time.

5) Internal Resistance to Tech Adoption

The innovation and commercialization teams in most traditional firms tend to have misaligned objectives.[16] Where the innovation team sees value, the commercialization team sees expense and risk. Xerox presents a cautionary tale: While its leadership failed to nurture the vision of its engineers who developed the Graphical User Interface, Apple and Microsoft incubated the technology into modern-day computers, creating

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15   Ivan Kot, "Lack of Standards Blockchain Technology: What to Do?," Itransition, June 26, 2018, https://www.itransition.com/blog/lack-of-standards-in-blockchain-technology-what-to-do.
Asha McLean, "Blockchain standards need definition agreement first: Standards Australia," *ZDNet*, Mar 6, 2017, https://www.zdnet.com/article/blockchain-standards-need-definition-agreement-first-standards-australia/.
Samburaj Das, China to Establish National Blockchain Standards by 2019: Govt. Official," *CCN: Cryptocurrency News*, May 10, 2018, https://www.ccn.com/china-government-to-establish-national-blockchain-standards-by-2019-report/.
Chuan Tian, "China Poised to Form Blockchain Standards Committee This Year," *CoinDesk*, May 28, 2018, https://www.coindesk.com/china-poised-to-form-blockchain-standards-committee-this-year/.

16   Rahul Kapoor and Thomas Kleuter, "Organizing for New Technologies," *MIT Sloan Management Review* 58, no. 2 (Winter 2017): 85-86, https://sloanreview.mit.edu/article/organizing-for-new-technologies/.

enormous value.[17] Mature firms often fall victim to status quo biases that create resistance to change.

6) Dearth of Skilled Human Resources & Capabilities

Given that blockchain technology is still evolving and its scope and limitations still being discovered, no single authority can provide all the knowledge that firms require. Developers and other human capital will be needed to come up with solutions and to work around limitations, but such individuals are scarce in the labor market.
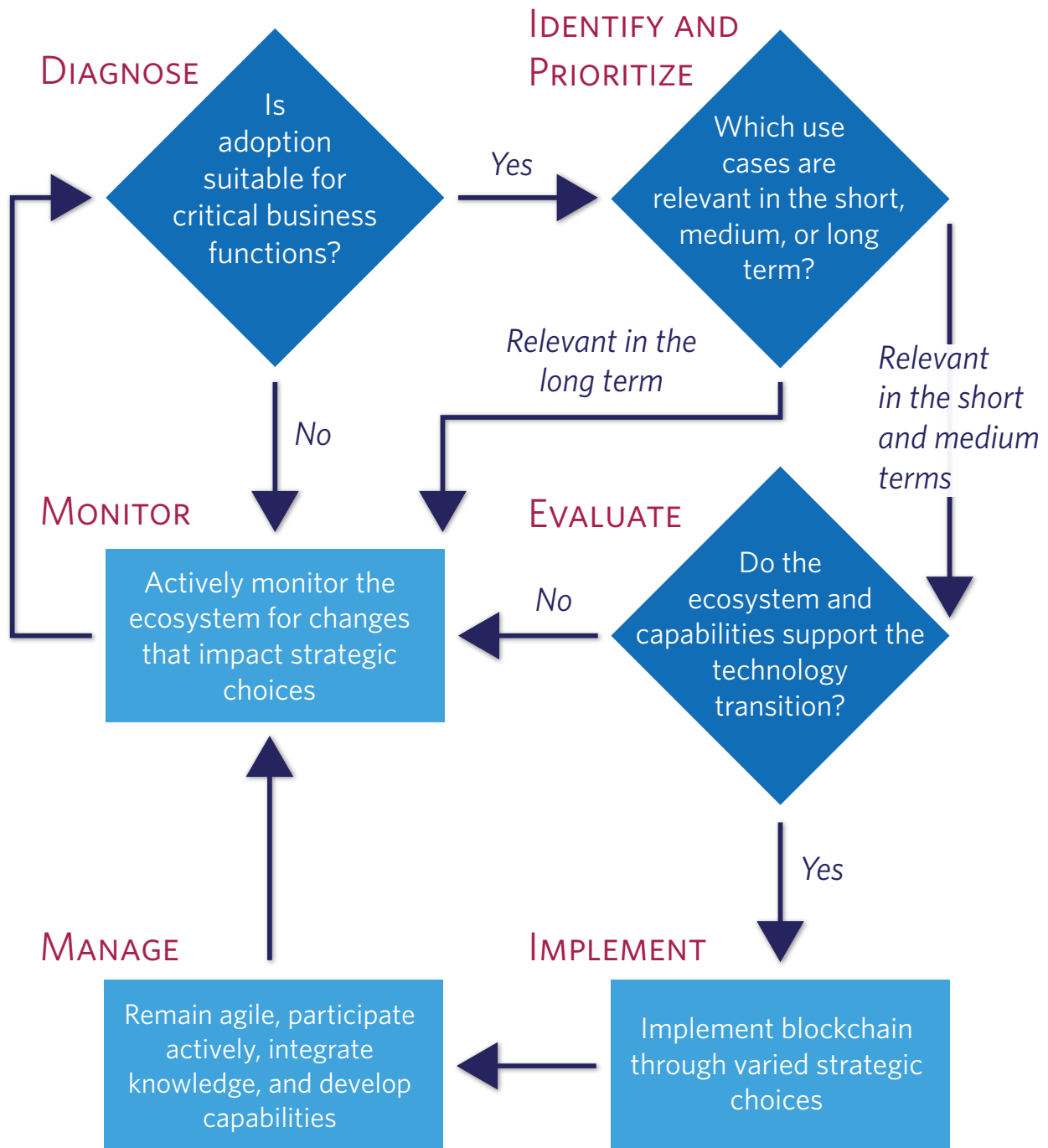
7) Regulatory Uncertainty

Although a few regulators, such as the state of Delaware, acknowledge the benefits of decentralized ledgers, widespread regulation cannot be put in place as long as the limitations and risks of implementation are unclear. And yet, large-scale adoption cannot take place until there is regulatory guidance. Hence, blockchain adoption is still a risky proposition today for critical business functions.

On top of these business challenges, technological concerns including security, interoperability among firms, and scalability will need to be addressed before firms can confidently adopt blockchain. ■

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17   Maxwell Wessel, "Big Companies Can't Innovate Halfway," *Harvard Business Review,* October 04, 2012, https://hbr.org/2012/10/big-companies-cant-innovate-halfway.

A Road Map and Four Key Questions

To help firms make informed decisions as they tread this unfamiliar and risky path, the Mack Institute has laid out a step-by-step road map that illustrates how to take a systematic approach while developing a blockchain strategy.

DIAGNOSE — Is adoption suitable for critical business functions?

IDENTIFY AND PRIORITIZE — Which use cases are relevant in the short, medium, or long term?

Yes

No

Relevant in the long term

Relevant in the short and medium terms

MONITOR — Actively monitor the ecosystem for changes that impact strategic choices

EVALUATE — Do the ecosystem and capabilities support the technology transition?

No

Yes

MANAGE — Remain agile, participate actively, integrate knowledge, and develop capabilities

IMPLEMENT — Implement blockchain through varied strategic choices

During each step of the way, it's important that organizations not get caught up in the hype surrounding blockchain but evaluate its merits independently. Moreover, since every step is crucial in today's fast-paced and highly competitive markets, we introduce four key questions for firms to ask themselves as they navigate this road map.

Diagnose

Do I Really Need Blockchain Now?

Technology shifts can prove disruptive, even fatal. Before changing technology strategies and committing resources, firms should evaluate whether the shifts are actually relevant to them at a given point in time. They should ask the fundamental question of whether they currently need blockchain at all.

To help answer this question, refer to the diagnostic matrix below. It overlays a firm's transaction measure with the technology's infrastructure measure to evaluate both the need for blockchain and the risk of adoption.

Interparty Transactions Index (ITI)

A firm's ITI is high if it conducts a high volume of transactions involving multiple parties that have a high counterparty risk of reneging on the contract terms. For instance, intra-firm transactions entail high trust and a low risk of non-compliance, while transactions involving several external vendors carry a higher risk of contract non-adherence.
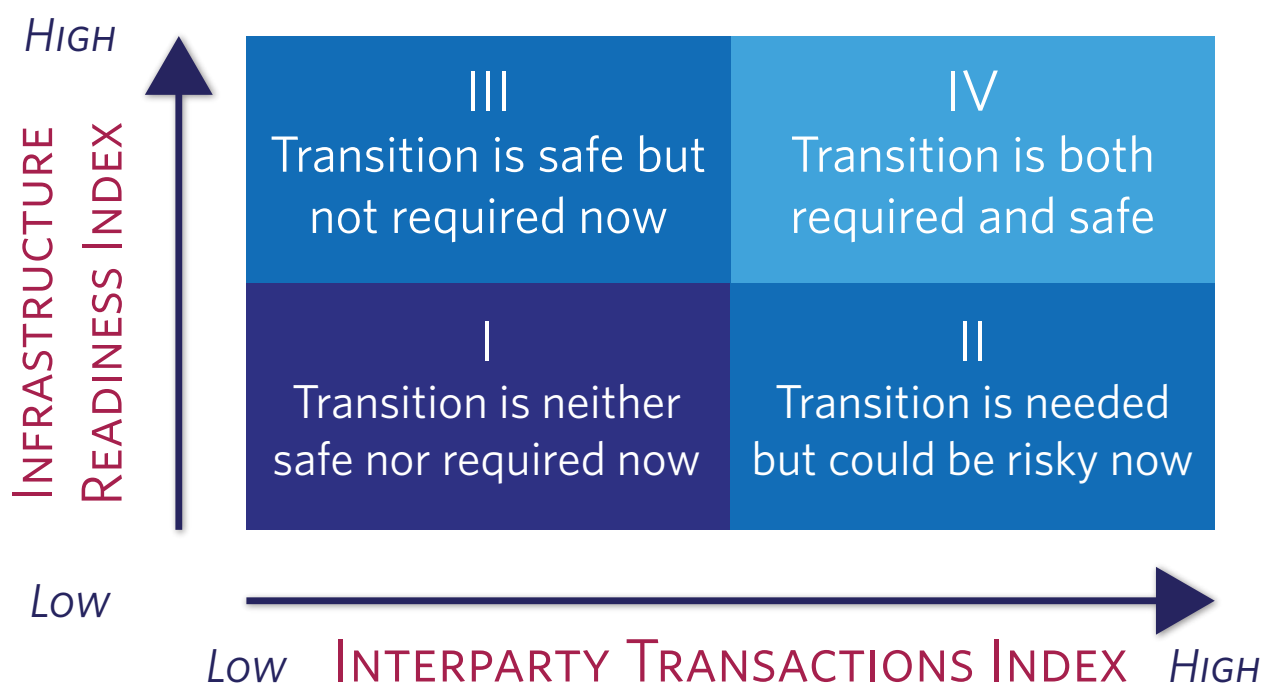
Infrastructure Readiness Index (IRI)

A newly deployed blockchain solution will require robust network infrastructure to operate at its full potential. A firm can measure its infrastructural readiness for dealing with mission-critical projects by two main parameters: scalability and privacy.

An effective blockchain solution will require a wide network of stakeholders on a common platform. The computing infrastructure should support the addition and coordination of players without overtaxing the network as adoption scales.

Decentralized data poses a higher risk of theft, especially of sensitive information such as financial or medical records. The firm should test the impenetrability of its infrastructure and address concerns of privacy and security before a blockchain solution can be deployed on it.

High scalability and low security risk translate to high infrastructure readiness.

III Transition is safe but not required now	**IV** Transition is both required and safe
I Transition is neither safe nor required now	**II** Transition is needed but could be risky now

INFRASTRUCTURE READINESS INDEX — High / Low

INTERPARTY TRANSACTIONS INDEX — Low / High

The higher the IRI is, the smaller the risk of adopting blockchain is. The higher the ITI is, the greater the need for blockchain is.

Quadrant I: Transition is Neither Safe nor Required Now

Small and medium enterprises operate with a limited number of vendors and low transaction volumes. Operational scalability therefore does not pose much concern (low ITI) and their needs can be met with existing technologies that are safer and cheaper than blockchain (low IRI). Such firms don't need to invest in blockchain until it is adopted widely. If they do decide to experiment at this early stage, they need to find ways to mitigate potential risks.

Quadrant II: Transition is Needed but Could Be Risky Now

Many large firms' existing businesses can benefit from disintermediation, transparency, smart contracts, provenance verification, decentralization, etc. (Examples include financial services firms, mining firms, retailers, and government departments.) But unless a firm is a technology provider, it will likely not be tech-ready for blockchain.

Firms that could benefit but don't have the capabilities to adopt blockchain can delay investing until the benefits outweigh the costs. Most firms operate with sensitive data and risk compromising their security and operations if their decisions are ill-informed.[18] The healthcare industry, for instance, could benefit greatly if patients' electronic medical records could be accessed by healthcare providers and insurance firms. However, applying an unproven technology to this kind of data could have serious repercussions. Such firms can avoid the blockchain path until it is proven.

Firms dealing with less sensitive data, such as Spotify or De Beers, could explore blockchain by borrowing competencies through tech partnerships. They could also invest in internal tech competencies if they have disposable resources, as BNY Mellon, Citi, and Comcast have done.

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18   Donald Sull, "Why good companies go bad," *Harvard Business Review,* July-August, 2000, https://hbr.org/1999/07/why-good-companies-go-bad.

Quadrants III & IV: Transition Is Safe

Firms with a high infrastructure readiness index tend to be large technology firms. For example, IBM, Microsoft, and Wipro have already been working to advance blockchain technology. Their business units that work with multiple external vendors have a high interparty transactions index. IBM's Financial Transaction Manager, for instance, supports vendor financing through multiple-party transactions. Adopting blockchain for this platform can make data reliable and transparent while improving the efficiency of transactions and dispute settlements.[19]

Other business units in these firms don't need to ensure the privacy of transactions or track the provenance of electronic parts; these have low ITI. Although such functions will have the required tech competencies, they won't need to adopt blockchain.

Regardless of which quadrant they fit into, firms should pay close attention to competitor activities and developments in their ecosystem to make informed decisions on tech strategies. First-mover advantages abound, but so do benefits for followers who learn from the failings of initial explorers.[20]

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19   Michael del Castillo, "IBM's Stellar Move: Tech Giant Uses Cryptocurrency in Cross-Border Payments," *CoinDesk,* October 16, 2017, https://www.coindesk.com/ibms-stellar-move-tech-giant-use-lumen-cryptocurrency-payments-rail/.

20   Marvin B. Lieberman and David B. Montgomery, "First-Mover Advantages," *Strategic Management Journal* 9, special issue (Summer 1988): 41-58, http://www.jstor.org/stable/2486211.
Marvin B. Lieberman and David B. Montgomery, "First-Mover (Dis)Advantages: Retrospective and Link with the Resource-Based View," *Strategic Management Journal* 19, no. 12 (December 1998): 1111-1125, http://www.jstor.org/stable/3094199.

III: Transition Is Safe but not Required Now	IV: Transition Is Both Required and Safe

■ Large tech firms (non-supply chain functions)
  – IBM, Microsoft, Wipro, Google, etc.
■ Small tech startups providing single or limited product solutions on shared infrastructure (blockchain-as-a-service) or on platforms provided by large tech firms
  – Everledger, Axoni, ShipChain, etc.
	
	■ Large tech firms (supply chain functions that need involve tracking multiple vendors)
	  – Intel, IBM, Microsoft, AWS, Wipro, Google, Cisco, etc.
	■ Non-tech firms that are building their tech competencies through internal resources or leasing shared infrastructure
	  – Verizon, Comcast, GE, BNY Mellon, Citi, Goldman Sachs, etc.

I: Transition Is Neither Safe nor Required Now	II: Transition Is Needed but Could Be Risky Now

■ Small and medium enterprises that have limited vendors, transactions, and resources
  – Startups, small manufacturers, cottage industries, one-shop retailers, local restaurants and service providers, SME brokers and money transfer services, etc.
■ Firms dealing in public transactions, publicly consumable goods, and shared resources that don't need scalability or privacy
  – Non-profit firms, charity organizations, religious institutions, government bodies, research, and educational institutions, Airbnb, Uber, etc.
	
	■ Firms dealing in health, medical records, and medical research data
	  – Hospitals, healthcare service providers
	■ Financial settlements, trading transactions, cross-border transactions, insurance and claims
	  – Vanguard, BNY Mellon, Nasdaq, Australian Securities Exchange, JP Morgan
	■ Automobile telematics tracking
	  – Volkswagen, Renault, Toyota, Daimler
	■ Supply chain, Retailers, CPG
	  – Bosch, Walmart, Alibaba, De Beers
	■ Telecommunication
	  – Verizon, Comcast, AT&T
	■ Aerospace
	  – Airbus, Boeing, GE, Air France, Lufthansa
	■ Shipping
	  – Maersk
	■ Government land registry and other document management functions

IRI High   *IRI Low*

ITI Low   *ITI High*

Identify & Prioritize

What's the Impact on My Existing Business?

Once a firm establishes its need and risk appetite for blockchain, it can evaluate the business value of investing in a solution. The firm should next identify appropriate use cases and evaluate blockchain's impact on its balance sheet.

To identify use cases, the firm can conduct a scenario planning exercise based on future state, efficiency gains, competitor moves, customer adoption, and uncertainties.[21] Refer to the adjacent box for steps on drawing up relevant use cases.

The identified use cases can then be stress-tested to see whether they make business sense. Firms need to focus on two key factors: quantifiable efficiency gains and operational inconveniences during adoption. A cost-benefit analysis should reflect efficiency gains such

Identifying Use Cases

First, use a top-down approach to identify which blockchain properties are relevant to firm operations. For instance, tracking the provenance of goods might be important for a retailer, while data privacy might be important for a bank and transparency for a law firm.

Next, through a bottom-up approach, identify operational inefficiencies that need intervention. Revisit the firm's organizational processes, customer journeys, and value chain to identify use cases for further evaluation. These top-down and bottom-up approaches, when combined, will highlight use cases for further evaluation.

Finally, draw up customer adoption and competitor adoption probabilities and a timeline for these use cases. This will determine the urgency and importance of intervention in each identified use case.

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21   Paul J.H. Schoemaker and V. Michael Mavaddat, "Scenario Planning for Disruptive Technologies," in *Wharton on Emerging Technologies*, ed. George S. Day and Paul J.H. Schoemaker with Robert E. Gunther (Hoboken, NJ: John Wiley & Sons Inc., 2000), chap. 10.
Rita Gunther McGrath, "A Real Options Logic for Initiating Technology Positioning Investments," *Academy of Management Re0view* 22, no. 4 (October 1997): 974-996, http://www.jstor.org/stable/259251.

as revenue increase through improved customer relationships and reduced capital expenditure and operational expenses over time. The firm can avoid disruptions to existing operations through open and candid conversations with technology providers on shared responsibilities. Conducting thorough analyses of the resources required will prevent cost overruns.[22]

As mentioned earlier, it will be difficult to gauge the exact impact of block-chain implementation. However, firms can make a reasonably accurate estimate using a combination of quantitative and qualitative measures. The sample chart below provides an example of how to prioritize use cases after a scenario analysis.[23] The circles represent relevant use cases, the circle sizes represent quantitative gains, and the axes represent qualitative factors. The expected impact on customer and sup-plier relationships determines each sce-nario's importance, and the likelihood and speed of adoption by customers and competitors determines its proba-bility. For instance, smart contracts can eliminate the need for humans to verify financial documents; service firms should therefore treat their adoption as highly probable and highly important.

Prioritizing Use Cases

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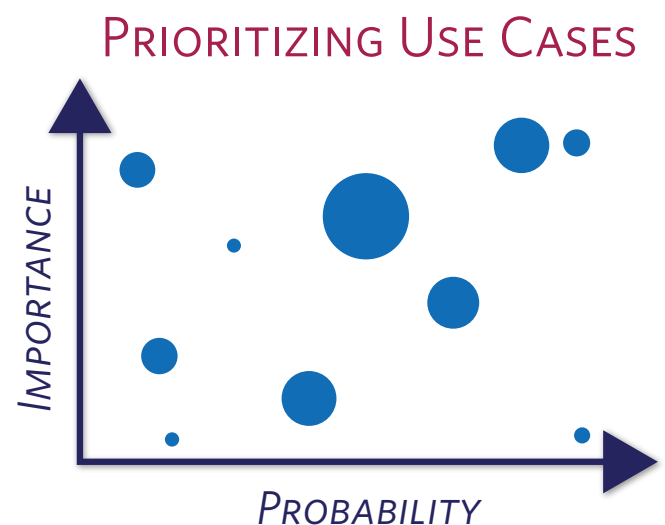
22   Interviews with technology firms supporting blockchain implementation, April 2018.

23   Schoemaker and Mavaddat, "Scenario Planning," in Day, Schoemaker, and Gunther, *Wharton on Emerging Technologies*, chap. 10.

EVALUATE & IMPLEMENT

WHAT ARE MY CHOICES FOR IMPLEMENTATION?

Implementing new technologies involves considerable risk, but firms can mitigate many of these risks and accelerate their learning by augmenting internal investments with open and external capabilities. By making strategic choices of internal investments, alliances, and acquisitions, firms can achieve varied levels of market exploration and risk mitigation along with varied controls over resources.[24]

1) INTERNAL INVESTMENTS

By retaining ownership and control over a technology and its related knowledge, firms often wield a competitive advantage. Firms can also strengthen their core competencies by investing in internal teams and building in-house capabilities. For instance, Microsoft is leveraging its own technology capabilities to build blockchain-based digital identities that encapsulate its users' data. It will use these identities to customize products and services at an individual level while also giving users control over their data.[25] Such internal methods of experimentation can help firms preserve control over valuable resources such as customers and data.[26] They can also create human resource capabilities, which are particularly valuable given the dearth of existing blockchain talent.

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24   Laurence Capron and Will Mitchell, *Build, Borrow, or Buy* (Boston, MA: Harvard Business Review Press, 2012).

25   Peggy Johnson, "Partnering for a Path to Digital Identity," *Microsoft* (blog), January 22, 2018, https://blogs.microsoft.com/blog/2018/01/22/partnering-for-a-path-to-digital-identity/.
Ankur Patel, "Decentralized Digital Identities and Blockchain – The Future as We See It," *Microsoft* (blog), February 12, 2018, https://cloudblogs.microsoft.com/enterprisemobility/2018/02/12/decentralized-digital-identities-and-blockchain-the-future-as-we-see-it/.

26   Capron and Mitchell, "When to Build: Internal Development Versus External Sourcing," in *Build, Borrow, or Buy*, chap. 2.

2) Alliances

In situations where internal resources are insufficient, alliances can enable firms to pool their strengths and create more value for their ecosystem than if they function individually.[27] For instance, Walmart collaborated with IBM to trace its pork supply from China and pinpoint where contamination was occurring. By bringing all the stakeholders in the value chain onto a secure blockchain network, it managed to record detailed shipping information including farm origination details, batch numbers, and storage temperatures. Based on this initiative's success, Walmart expanded the pilot to mangoes and reduced the time taken to track them from seven days to 2.2 seconds.[28]

Firms that don't want to expend initial infrastructure costs can utilize technology platforms that facilitate experimentation such as Hyperledger, Ethereum, and HydraChain.[29] Consortiums such as R3, Enterprise Ethereum Alliance, and Ripple are bringing together industry players and technology firms to leverage each other's strengths and co-develop solutions that would be difficult to create if the firms operated independently.[30] Partnerships are already forming in financial services, healthcare, shipping, government, and many other industries.

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27   Adam M. Brandenburger and Barry J. Nalebuff, *Co-opetition* (New York: Doubleday, 1996).

28   Naidu and Irrera, "Nestle, Unilever, Tyson," *Reuters*.

29   CB Insights, *Corporate Trends in Blockchain* (September 2017), Webinar recording, 33:30, https://www.cbinsights.com/research/briefing/corporates-in-blockchain/recording/.
Rohas Nagpal, "17 blockchain platforms—a brief introduction," *Medium* (blog), April 12, 2017, https://medium.com/blockchain-blog/17-blockchain-platforms-a-brief-introduction-e07273185a0b.

30   Day and Schoemaker, "A Different Game," in Day, Schoemaker, and Gunther, *Wharton on Emerging Technologies*, chap. 1.
Marquis Cabrera, "Use co-opetition to build new lines of revenue," *Harvard Business Review,* February 10, 2014, https://hbr.org/2014/02/use-co-opetition-to-build-new-lines-of-revenue.
Eric Lowitt, "Why your company should partner with your rivals," *Harvard Business Review,* March 12, 2012, https://hbr.org/2012/03/why-your-company-should-partne.

Given blockchain's nascence, alliances might make the most sense for pooling complementary capabilities and co-creating solutions. However, for multi-party alliances to succeed, firms that share data and resources in such consortiums have to clearly define roles for control, authority, and responsibility to manage contingencies.[31]

3) Acquisitions

A quicker way to build capabilities is to acquire startups already working on blockchain solutions. If the two organizations possess complementary capabilities and integration is possible, acquisitions can create reciprocal synergies and give the firm greater control over outcomes.[32] For instance, to solve its problem of content ownership attribution and royalty payments, Spotify acquired Mediachain Labs, which was building a distributed database linking content to creators.[33] Mediachain's technology complemented Spotify's database, and their common customer domain made integration easier. When a future vision and integration path can be clearly defined, and knowledge can be plowed back into a firm to enhance its internal capabilities, acquisitions make the most sense.[34]

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31   Henry W. Chesbrough, "The Era of Open Innovation," *MIT Sloan Management Review* 44, no. 3 (Spring 2003): 35-41, https://sloanreview.mit.edu/article/the-era-of-open-innovation/.

32   Capron and Mitchell, "When to Buy: Acquisition Versus Alternatives," in *Build, Borrow, or Buy*, chap. 5.

33   Hugh McIntyre, "Spotify Has Acquired Blockchain Startup Mediachain," *Forbes,* April 27, 2017, https://www.forbes.com/sites/hughmcintyre/2017/04/27/spotify-has-acquired-blockchain-start-up-mediachain/#341aa70d69ee.

34   Gary Dushnitsky and Michael J. Lenox, "When do incumbents learn from entrepreneurial ventures? Corporate venture capital and investing firm innovation rates," *Research Policy* 34, no. 5 (June 2005): 615-639, https://doi.org/10.1016/j.respol.2005.01.017.

Note that in acquisitions, human knowledge and capabilities are often more valuable than products.[35] Acquisitions can solve the problem of talent scarcity for incumbents. For instance, Japanese e-commerce player Rakuten acquired a bitcoin payments startup to launch its own blockchain lab, while Airbnb acquired just the team of engineers from the startup ChangeCoin.[36]

Since each of these strategies presents its own merits and constraints, incumbents that succeed in technologically advancing markets will typically take a multi-pronged approach toward exploring new technologies.[37] Qiwi offers an example of such an approach. The

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35   Saikat Chaudhuri and Behnam Tabrizi, "Capturing the Real Value in High-Tech Acquisitions," *Harvard Business Review,* September-October, 1999, https://hbr.org/1999/09/capturing-the-real-value-in-high-tech-acquisitions.

36   Biz Carson, "Airbnb just brought on a team of bitcoin experts from a tiny startup," *Business Insider,* April 12, 2016, http://www.businessinsider.com/airbnb-buys-bitcoin-startup-changecoin-2016-4.

37   Capron and Mitchell, "Developing Your Enterprise Selection Capability: The Balance Imperative," in *Build, Borrow, or Buy*, chap. 7.

Six Banks in Canada Are Investing in an Inter-bank Blockchain Solution

Royal Bank of Canada, TD Bank, Scotiabank, Canadian Imperial Bank of Commerce, Bank of Montreal, and Desjardins are investing in a digital ID service that allows secure transmission of data. The centralized SecureKey system uses blockchain to create a public ledger of verified Know-Your-Customer data and shares the information with all banks in the network.

For other banks wishing to join this network, a KYC-documentation use case will be highly important: as major competitors adopt the solution, their service quality will rise. Probability of customer adoption will also be high given the relatively small size of the Canadian economy.

However, a use case of digitizing bank-vendor transactions on this blockchain will be less important. Even though the probability of competitor adoption is high, existing technologies can serve vendor transactions well enough that relationships will not be adversely affected. Moreover, competitor adoption might not necessarily impact firm-vendor relationships in any significant way.

Russia-based payments service provider began by engaging in the R3 block-chain consortium, then focused on gaining comfort with the technology, then built its own research subsidiary for knowledge integration.[38] It expanded its internal innovation platform by also acquiring blockchain startups.

Pursuing a variety of paths into the future also helps incumbents reduce the probability of shock when unexpected market changes happen.[39] Ignoring market readiness and investing in new technologies at the wrong time can be fatal, as Sears and Nokia demonstrated.[40] Managers would do well to maneuver strategies to keep up with the advancing blockchain ecosystem. This will require staying close to developments in their industry, remaining engaged, and iterating their strategic choices over time. As competitors and other stakeholders develop more robust use cases and tighten the loose ends, strategic engagements with other players can help firms stay on top of their game.

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38   Armando Noguera, "Qiwi Creates a Blockchain-based Subsidiary," *Infocoin.net,* March 6, 2017, http://infocoin.net/en/2017/03/06/qiwi-creates-a-blockchain-based-subsidiary/.
Stan Higgins, "Russian Payments Giant Qiwi Acquires Blockchain Startup," *CoinDesk,* May 16, 2017, https://www.coindesk.com/russian-payments-giant-qiwi-acquires-blockchain-startup/.
Pete Rizzo, "Payments Giant Qiwi is Building a Blockchain Replacement for its Core Database," *CoinDesk,* May 20, 2016, https://www.coindesk.com/qiwi-replace-payments-processor-blockchain/.

39   Shona L. Brown and Kathleen M. Eisenhardt, "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly* 42, no. 1 (March 1997): 1-34, doi:10.2307/2393807.

40   Yves Doz, "The Strategic Decisions That Caused Nokia's Failure," *INSEAD Knowledge,* November 23, 2017, https://knowledge.insead.edu/strategy/the-strategic-decisions-that-caused-nokias-failure-7766.
Incisiv Inc., *Me Too Omnichannel Erodes Profitability* (Q4, 2017), http://www.incisiv.io/ebook-me-too-om-nichannel-erodes-profitibality.
Kenneth C. Laudon and Jane P. Laudon, "Achieving Competitive Advantage with Information Systems: Will Technology Save Sears," in *Essentials of Management Information Systems* (Upper Saddle River, NJ: Prentice Hall), 106-108, http://blackhawk.cs.mercer.edu/courses/David%20Cozart/IST%20349/Downloads/Case%20Studies/CH3-CS3.pdf.

MANAGE & MONITOR

HOW DO I PREPARE FOR LONG-TERM SUSTAINABILITY?

The adjacent S-curve chart, familiar to many, indicates that a new technology advances by cumulative engineering effort. Empirical evidence shows that technology substitution is characterized by the surrounding ecosystem evolution.[41] Accordingly, blockchain's progress and long-term success will largely depend on how well its surrounding ecosystem develops. For instance, Maersk's success at tracking its shipment supply chain will hinge on the readiness of all stakeholders end-to-end in the supply chain. If all parties in the ecosystem are not infrastructurally ready, familiar with, or comfortable with handling the technology, the solution cannot run smoothly. Each player needs to recognize snags in its own processes and resolve them. The cumulative effort will catalyze the technology's advancement and improve the solution's performance.
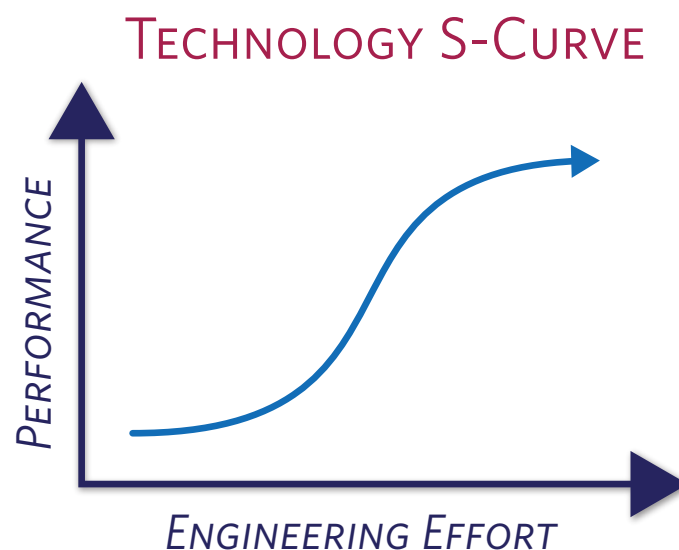
A firm's active participation in ecosystem development is the foremost factor in ensuring long-term sustainability. Along with co-developing solutions with other stakeholders, managers can actively lobby regulators to share their

TECHNOLOGY S-CURVE

PERFORMANCE

ENGINEERING EFFORT

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41   Ron Adner and Rahul Kapoor, "Innovation Ecosystems and the Pace of Substitution: Re-Examining Technology S-Curves," *Strategic Management Journal* 37, no. 4 (January 2015): 625-648, http://dx.doi.org/10.1002/smj.2363.

knowledge and help create a sensibly regulated environment while also enhancing their firm's credibility.

The second key factor for sustainability is knowledge integration. Emerging technologies almost always develop in networks. As the network expands, capabilities grow and the complexity of knowledge increases. Knowledge management becomes critical and has to be redirected to the firm's advantage.[42] Mitsubishi, for instance, is well-known for growing its market share by strengthening its active network position through alliances and enhancing its technological capabilities.[43] Firms that are exploring blockchain through a variety of internal and external innovations can utilize consortiums to gain and share knowledge.

The third factor for sustainability is establishing processes to transfer knowledge quickly and effectively across the organization. To build unique competencies and supplement human skillsets, organizations need to support environmental scanning, experimentation, and integration of knowledge into actionable tasks.[44] Boeing, for example, commissioned a formal group to study difficulties in the development of its 737 and 747 planes and compare the process with that of its most profitable planes, the 707 and 727. Boeing then formalized the lessons in writing to guide the team building its next set of aircraft. Similarly, British Petroleum established a project appraisal unit to review investments regularly, deduce lessons, and incorporate the insights into future plans. Given that blockchain is still in its early stages, agile learning

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42   Lori Rosenkopf, "Managing Dynamic Knowledge Networks," in Day, Schoemaker, and Gunther, *Wharton on Emerging Technologies*, chap. 15.

43   Toby E. Stuart and Joel M. Podolny, "Local Search and the Evolution of Technological Capabilities," *Strategic Management Journal* 17, no. S1 (Summer 1996): 21-38, https://doi.org/10.1002/smj.4250171004.

44   Satyendra Singh, Yolande E. Chan, and James D. McKeen, "Knowledge Management Capability and Organizational Performance: A Theoretical Foundation" (Organisational Learning, Knowledge and Capabilities Conference paper, University of Warwick, Coventry, UK, March 20-22, 2006).
Richard R. Nelson and Sidney G. Winter, *An Evolutionary Theory of Economic Change* (Cambridge, MA: Harvard University Press, 1982).

processes that integrate learning into day-to-day activities can help the technology progress faster. Such processes can minimize the incidence of failures and also diminish internal resistance to new technology adoption.[45]

Note that the three factors mentioned above — active participation in ecosystem development, knowledge integration, and quick knowledge transfer across the organization — hinge upon the sustained development and engagement of human capital. A firm's innovation success depends on managerial capabilities to connect the dots appropriately, especially when it comes to integrating lessons from pilot blockchain projects into the firm.[46] Like GE and Ford, which partnered with technology firms to access talent, incumbents can close talent gaps through partnerships.[47] Partnerships with educational institutions and consulting firms can further supplement skill development programs. Addressing the blockchain talent crunch is possible, but will require firms to reassess skills, reorganize resources, and invest in training and development, all of which will challenge incumbents to shake off their inertia. ■

45   Marco Iansiti and Alan MacCormack, "Developing Products on Internet Time," *Harvard Business Review,* September-October 1997, https://hbr.org/1997/09/developing-products-on-internet-time.

46   Rebecca M. Henderson and Kim B. Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," *Administrative Science Quarterly* 35, no. 1 (March 1990): 9-30, doi:10.2307/2393549.

47   Michael Mankins, "How Leading Companies Build the Workforces They Need to Stay Ahead," *Harvard Business Review,* September 07, 2017, https://hbr.org/2017/09/how-leading-companies-build-the-workforces-they-need-to-stay-ahead.

How GlaxoSmithKline (GSK) Is Creating a Blockchain-based Model to Manage Product Line Supply Chains

To detect illegitimate drug products and ensure patient safety, the U.S. Drug Supply Chain Security Act (DSCSA) has mandated that pharmaceutical companies track and trace drugs at the retail-unit level by 2023. The act requires a detailed digital record of who has handled the product and where, starting from the manufacturer all the way to the local pharmacist. This is a difficult task for large firms such as GSK, which have complex processes and wide distribution networks. GSK scientists looking for tracking solutions took cues from Walmart's success in tracking pork products from China using blockchain. The technology's immutability and time efficiency attracted them, so they set out in search of a blockchain-based solution to establish drug provenance irrefutably and meet their regulatory requirements.

First, GSK identified a non-critical use case that would be safe to experiment with: tracking cell lines for cell engineering. Cell lines are cultures that scientists use to edit and study biological processes (genome editing). Some activities in GSK's cell engineering value chain were inefficient. Specifically, multiple license verifications made stock management and request fulfillment at its BioRepository laborious and time-consuming. When a GSK scientist requested certain cell lines for experiments, the BioRepository needed time to verify the scientist's license and access rights. It then had to verify stock availability before approving. Since it worked separately from the procurement team for stocking cell lines, replenishment time and demand time often got mismatched, resulting in delays.

To initiate the pilot, GSK's scientists had to work around certain hurdles. The first was to obtain approvals from the leadership team, for which they had to construct a sound business case. By citing Walmart's success, and after much deliberation on the estimated dollar efficiency gains, they managed to persuade the leadership to run a pilot. Next, to alleviate data security concerns, they voted to build a private internal blockchain. To minimize operational disruptions for the rest of the firm, they involved only a limited number of stakeholders. Finally, they negotiated and brought the BioRepository team, procurement team, external vendors, and a sample team of scientists on board.

While their business case was clear, the scientists did not have a working knowledge of blockchain. To fill this skill gap, they looked outside the firm for experts and hired Viant, an Ethereum-based blockchain platform. Viant built a pilot solution around GSK's existing computing infrastructure instead of upgrading it in order to limit capital expenditure.

Under the pilot solution, pre-written smart contracts verify a scientist's license and validate permission instantly when he or she requests a cell line. The application simultaneously verifies data on stock availability at the BioRepository, triggers delivery to the scientist, and alerts the vendor when replacement and replenishment of cell lines is required. Payments happen automatically since both the vendor and its bank are on the blockchain. GSK can provide regulators with access if needed. As an added benefit, the cryptographical nature of the application allows stakeholders to access only the portions of the supply chain relevant to their business. For instance, a vendor can be granted access to just the freezer unit while other aspects of the cell engineering process remain inaccessible.

GSK's pilot has yielded a holistic cell line tracking system that enables cost and time efficiencies as well as secure data sharing. By replicating this program to drug products with a larger volume of stakeholders, GSK would be able to fulfill the DSCSA's tracing mandate. Furthermore, since license ownership can be easily traced, GSK can share its experimental research with its scientists all over the world without risking misuse of information.

Following improvements in the healthcare data ecosystem, GSK is planning to extend this experiment to enable secure data exchange among researchers, patients, and clinical research centers. It plans to continue monitoring market adoption for blockchain and envisions solutions for managing pharmacogenomic data for clinical studies, patient enrollment, trial monitoring, managing consent, and more. ■

Looking Forward

Blockchain is a promising new technology, and when combined with the wave of other technologies including machine learning, AI, big data, and predictive analytics, it can be a powerful tool to transform industries. However, managers would do well to take a measured path rather than jumping to adopt the technology in fear of missing out. As blockchain matures and critical implementation challenges are addressed, organizations can stay involved by taking active roles in consortiums and alliances that share knowledge.

As with any emerging technology, in order to cross the chasm in the innovation adoption lifecycle, managers need to persist with innovation.[48] They need to budget and strategize not only for technology development, but to ready themselves to cannibalize existing products and self-disrupt current business models if necessary.[49] Firms that invest in their resources, build institutional capabilities, and nurture new competencies will be well-equipped to deliver a robust strategic response to their competition.[50] ■

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48   Geoffrey A. Moore, *Crossing the Chasm* (New York, NY: HarperBusiness, 1991).

49   Everett M. Rogers, *Diffusion of Innovations* (New York, NY: Macmillan Publishing, 1983).

50   Christine Oliver, "Sustainable Competitive Advantage: Combining Institutional and Resource-Based Views, *Strategic Management Journal* 18, no. 9 (1997): 697-713, https://doi.org/10.1002/(SICI)1097-0266(199710)18:9%3C697::AID-SMJ909%3E3.0.CO;2-C.

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