

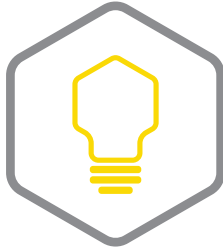
BLOCKCHAIN AND THE PROJECT MANAGEMENT OFFICE

A Distributed Platform for Strategy Delivery and Organizational Transformation

Anthony D. Williams, Ricardo Viana Vargas,
Edivandro Carlos Conforto, and Tahirou Assane Oumarou
Blockchain Research Institute and Brightline Initiative

May 2019





Realizing the new promise of the digital economy

In 1994, Don Tapscott coined the phrase, “the digital economy,” with his book of that title. It discussed how the Web and the Internet of information would bring important changes in business and society. Today the Internet of value creates profound new possibilities.

In 2017, Don and Alex Tapscott launched the Blockchain Research Institute to help realize the new promise of the digital economy. We research the strategic implications of blockchain technology and produce practical insights to contribute global blockchain knowledge and help our members navigate this revolution.

Our findings, conclusions, and recommendations are initially proprietary to our members and ultimately released to the public in support of our mission. To find out more, please visit www.blockchainresearchinstitute.org.



Blockchain Research Institute, 2019

Except where otherwise noted, this work is copyrighted 2019 by the Blockchain Research Institute and licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International Public License. To view a copy of this license, send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA, or visit creativecommons.org/licenses/by-nc-nd/4.0/legalcode.

This document represents the views of its author(s), not necessarily those of Blockchain Research Institute or the Tapscott Group. This material is for informational purposes only; it is neither investment advice nor managerial consulting. Use of this material does not create or constitute any kind of business relationship with the Blockchain Research Institute or the Tapscott Group, and neither the Blockchain Research Institute nor the Tapscott Group is liable for the actions of persons or organizations relying on this material.

Users of this material may copy and distribute it as is under the terms of this Creative Commons license and cite it in their work. This document may contain material (photographs, figures, and tables) used with a third party’s permission or under a different Creative Commons license; and users should cite those elements separately. Otherwise, we suggest the following citation:

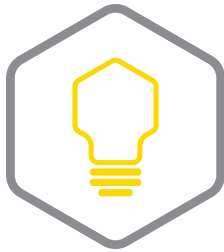
Anthony D. Williams, Ricardo Viana Vargas, Edivandro Carlos Conforto, and Tahirou Assane Oumarou, “Blockchain and the Project Management Office: A Distributed Platform for Strategy Delivery and Organizational Transformation,” foreword by Don Tapscott, Blockchain Research Institute, 17 May 2019.

To request permission for remixing, transforming, building upon the material, or distributing any derivative of this material for any purpose, please contact the Blockchain Research Institute, www.blockchainresearchinstitute.org/contact-us, and put “Permission request” in subject line. Thank you for your interest!



Contents

Foreword	3
Idea in brief	4
Introduction	5
A brief blockchain primer for project managers	8
Disrupting project management: PMOs in transition	9
Networked corporations and decentralized organizations	10
Disruptive technologies	12
Faster clock speeds and continuous innovation	13
Blockchain and the PMO: A new platform for managing complex projects	15
Blockchain pilots in project management	17
Blockchain-enabled clinical trials: Cutting through project complexity	18
Smarter construction: The potential of smart contracts for PMOs	23
Securing the global food system: New tools for PMOs	28
Conclusion and recommendations	34
About the authors	39
About the Blockchain Research Institute	41
About the Brightline Initiative	42
Notes	42



Foreword

In *Blockchain Revolution*, Alex Tapscott and I discussed how blockchain technology can impact all areas of business and society. Project management is well-suited for blockchain given that the technology's core characteristics such as transparency and auditability support speed, accuracy, and confidence. However, our research shows that while most executives understand the potential of blockchain to inform strategy and minimize decision-making biases in the boardroom and C-suite, not many have made significant progress.

This project takes a deep dive into the current state of project management and identifies key areas for improvement. It discusses five key areas where blockchain technology can improve project management including storing of digital records, exchanging digital assets, reinforcing and verifying proper stakeholder behavior, building reputation systems, and executing smart contracts. It presents case studies of enterprises that are currently deploying blockchain to improve project management, including which activities are suitable (or not suitable).

This project takes a deep dive into the current state of project management and identifies key areas for improvement.

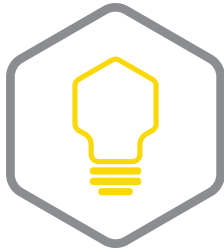
This white paper is one of our series of collaborations with the Brightline Initiative. Working with Anthony D. Williams—who was co-author of *Wikinomics: How Mass Collaboration Changes Everything*, and its sequel, *Macrowikinomics: New Solutions for a Connected Planet*—are three of Brightline's thought leaders. Ricardo Viana Vargas is one of the world's leading experts in the field of project management. He has worked as an executive and a portfolio manager, written 15 books, and hosts the sage podcast, *Five Minutes Project Management*. Edivandro Carlos Conforto is head of strategy research at the Brightline Initiative and a thought leader on organizational agility, strategy implementation, and agile transformation. Tahirou Assane Oumarou is the director of operations of the Brightline Initiative and was formerly the deputy director of infrastructure and project management group in the United Nations Office for Project Services. This research is a must-read for managers and entrepreneurs looking to compete more effectively in their domains.



DON TAPSCOTT

*Co-Founder and Executive Chairman
Blockchain Research Institute*





Idea in brief

Blockchain technology can improve project management in five areas: storing digital records, exchanging digital assets, ensuring acceptable behavior, building reputation systems, and executing smart contracts.

- » Project management offices (PMOs) are always looking for better ways to achieve strategic objectives and support organizational change through project work. Regardless of the industry sector, however, projects and programs regularly falter or fail outright, and about ten cents of every dollar are wasted because of poor project performance.¹
- » The rise of disruptive technologies and the shift to highly networked models of value creation are among the forces driving a growing proportion of PMOs to invest in the skills and capabilities required to help their organizations bridge the costly gap between strategy and value delivery.
- » Blockchain technology holds promise for improving many functions of the PMO. Blockchain's core characteristics, including transparency and auditability, create an environment of trust for project teams, senior management, and stakeholders, where people and institutions can act with speed and confidence.
- » Blockchain can help PMOs and their stakeholders by automating record-keeping, reconciliation, and basic coordination tasks, thereby freeing managers for more challenging and value-adding activities. Blockchain-enabled PMOs can take advantage of automation to hasten their transition from passive entities that manage scope, costs, and schedules to active, adaptive partners who lead and execute strategic initiatives.
- » These are the early days of blockchain applications in project management, which currently center on payments, provenance, and data management, but could apply throughout the project management process. Pointing the way are use cases in pharmaceuticals, construction, and the closely related domain of supply chain management.
- » Early experiments reveal how blockchain could streamline the management of such complex projects as clinical trials, how smart contracts could revolutionize the management of complex development projects, and how PMOs have new tools for managing transparency and instilling trust.
- » The circumstances where PMOs will most benefit from blockchain include those with complex and distributed activities, and those under regulatory compliance or quality certification requirements for rigorous verification and auditing.



Introduction

The Belt and Road Initiative represents the leading economic development initiative of our time.

At first glance, a seaport in Pakistan, bridges in Bangladesh, an industrial park in Cambodia, and railways to Russia seem like unrelated infrastructure projects. In reality, they are all part of Chinese President Xi Jinping's grand plan to unleash trade and commerce across six overland and maritime trade corridors stretching across Asia, Europe, Africa, South America, and the Middle East.

Hailed as the largest global collaboration on infrastructure development since the post-WWII Marshall Plan, the so-called Belt and Road Initiative represents the leading economic development initiative of our time—one that has grown from 65 countries to 135, involving over 80 percent of the world's population, generating just over half of its gross domestic product, and moving at least a quarter if not half of all the world's goods and services (Table 1).²

Table 1: List of countries participating in the Belt and Road Initiative

The project has more than doubled in size, growing from 65 to 135 countries, many of those in Africa, Central and South America, with islands in the Caribbean and the South Pacific. (The new countries appear in *italics*.)

Region	Country
Africa	<i>Algeria, Angola, Burundi, Cameroon, Cape Verde, Chad, Republic of Congo, Cote d'Ivoire, Djibouti, Egypt, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Kenya, Libya, Madagascar, Mauritania, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe</i>
Caribbean	<i>Antigua and Barbuda, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Jamaica, Trinidad and Tobago</i>
Central America	<i>Costa Rica, El Salvador, Panama</i>
Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
East Asia	China, Mongolia, <i>South Korea</i>
Europe	Albania, Armenia, <i>Austria</i> , Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Greece, Hungary, <i>Italy</i> , Latvia, Lithuania, <i>Luxembourg</i> , North Macedonia, <i>Malta</i> , Moldova, Montenegro, Poland, <i>Portugal</i> , Romania, Russia, Serbia, Slovakia, Slovenia, Turkey, Ukraine
Middle East	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen
South America	<i>Bolivia, Chile, Ecuador, Guyana, Suriname, Uruguay, Venezuela</i>
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Southeast Asia	Brunei, Cambodia, Indonesia, Laos, Malaysia, <i>Micronesia</i> , Myanmar, <i>New Zealand, Papua New Guinea</i> , Philippines, Singapore, Thailand, Timor-Leste, Vietnam
South Pacific	<i>Cook Islands, Fiji, Niue, Samoa, Tonga, Vanuatu</i>

Source of data: Hong Kong Trade Development Council, "The Belt and Road Initiative: Country Profiles," as of 5 May 2019.



For project managers, the Belt and Road Initiative signifies a new kind of complex project and a new model of project management—one where the assets, expertise, and resources to perform a task or solve a problem are mobilized across organizational and geographic boundaries; where project managers seek input and engagement from diverse stakeholders; and where disruptive technologies such as artificial intelligence (AI) and blockchain enable far-flung collaborations and speed up project execution.

The momentous project includes \$4 trillion of new investment to make it easier for Europe, Asia, Africa, and the Middle East to trade goods with China.

The momentous project includes \$4 trillion of new investment in roads, railways, bridges, telecommunications networks, power plants, and a series of seaports—all to make it easier for Europe, Asia, Africa, and the Middle East to trade goods with China.³ All this new investment is laying the terrestrial foundation for a new era of supercharged interregional trade. But the physical infrastructure is just the beginning.



White and Blue Ship on Water by Quang Nguyen Vinh, no date, used under Pexels license, accessed 9 May 2019.

The Belt and Road Blockchain Consortium is building a parallel “digital silk road” to enable speedy, secure, and transparent cross-border transactions.

Conceived as the digital twin to its physical counterpart, the Belt and Road Blockchain Consortium (BRBC) is building a parallel “digital silk road” to enable speedy, secure, and transparent cross-border transactions. Its participants include port and line operators, logistics and freight forwarding operators, liquidity providers (banks, trade credit insurance, trade finance), professional services firms (accounting firms, credit rating agencies), and international standards bodies. They meet monthly in Hong Kong to hash out blockchain-enabled solutions for verifying identities, issuing payments, advancing safety and security protocols, expediting customs settlements, and enabling efficient border controls.⁴



It's arduous work that involves complex efforts to harmonize regulatory frameworks and stitch together interoperable digital protocols. But Pindar Wong, chief architect of the BRBC, sees a big upside: a thriving trade bloc with increasingly borderless markets where digital identities, smart contracts, and reputation mechanisms enable buyers and sellers to enter into secure transactions with unprecedented speed and immediacy. "As leading supply chains evolve into highly automated, data-driven ecosystems, they will need the transparency, immutability, and accountability that blockchains provide," said Wong.⁵

From a project management perspective, the Belt and Road Initiative represents an unparalleled effort to align economic and diplomatic interests and incentives across countries, harmonize local rules and regulations, share best practices and intellectual property, and provide ongoing governance for a complex, decades-long endeavor. For the PMOs tasked with bringing intricate international undertakings like these to fruition, the project heralds the arrival of next-generation models where PMOs are equipped to sense and respond to change, to internalize and champion their organization's strategic objectives, to stay on top of emerging technologies, and to understand how the projects they manage are positioning their organization to be more competitive in today's marketplace.

In the new model of project management, getting the right people, and the right mix of languages, skills, disciplines and, above all, cultural attitudes, is essential to improving outcomes.

While PMOs have traditionally and primarily been set up as administrative bodies that manage the quintessential project management triangle of time, scope, and costs, next-generation project management executives will need new skillsets and an enhanced capacity to lead and execute strategic initiatives. In the new model of project management, getting the right people, and the right mix of languages, skills, disciplines and, above all, cultural attitudes, is essential to improving outcomes, as highlighted in the third of ten guiding principles of the Brightline Initiative.⁶ So, too, is the capacity to apply emerging technologies like blockchain to create smarter, streamlined processes. The purpose of this paper is threefold:

- » To discuss the role and value of a PMO in delivering strategy and organizational transformation, since many are still not familiar with PMO, let alone its relationship to strategy.
- » To discuss how enterprises can harness blockchain to streamline and automate an array of project management functions through the PMO.
- » To discuss findings on how leading organizations are using blockchain to manage project work, and to identify key lessons and takeaways from these pioneering efforts.



A brief blockchain primer for project managers

Its capacity to increase data security, immutability, and visibility make blockchain an indispensable tool for managing complex projects.

A blockchain is a distributed ledger of transactions, a database with special characteristics.⁷ It is structured as a continuously growing list of records (blocks), each with transaction data and a timestamp, that are linked and secured cryptographically. New blocks are added only after being validated by consensus of a peer-to-peer network of participants (Figure 1). There is no central authority approving or rejecting transactions. The blockchain is replicated across all the nodes of the blockchain network, and so transactions are visible to all participants. Once added, blocks cannot easily be altered. Parties can only change a transaction with the addition of a new block. As a result, the blockchain provides an immutable and auditable history of what has happened.

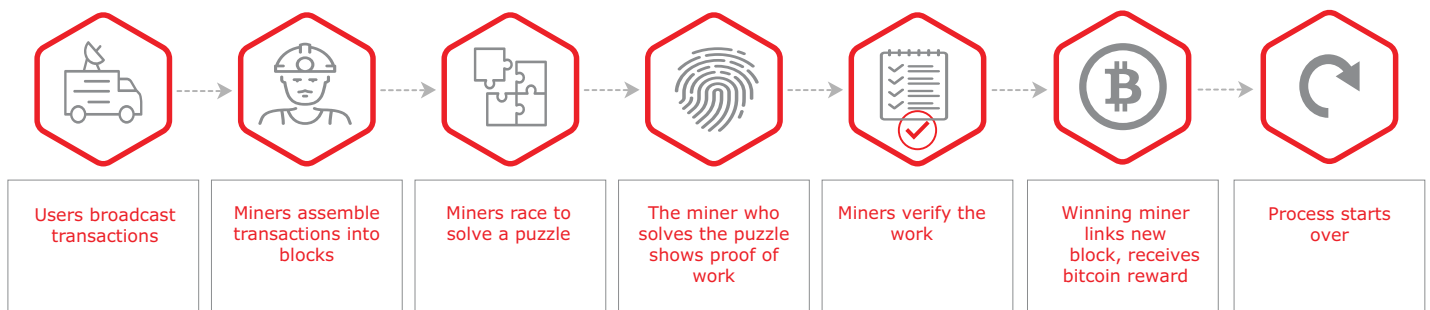
Those characteristics make blockchains more secure, less vulnerable to tampering, and more transparent than many centralized information technology (IT) systems that have proven vulnerable to hacking. The Internet-only systems used by Facebook, Uber, British Airways, T-Mobile, Reddit, and FedEx, for example, were all breached in 2018.⁸ Since then, Facebook has launched its own crypto initiative and hired some top blockchain engineers amid the crypto downturn and layoffs.⁹

The capacity to increase data security, immutability, and visibility make blockchain an indispensable tool for managing complex projects where success depends on the ability to mobilize people and resources across organizational boundaries. These features can improve the functions of a PMO and business outcomes in numerous ways:

- » Storing digital records of importance, such as digital identities, contracts and payments, the provenance and ownership of assets, and other data that must be carefully protected.

Figure 1: How blockchain works

Miners refer to those devices running the full blockchain software stack and competing to solve a difficult mathematical problem and create the next block, in exchange for a cryptocurrency reward. The term also refers to the parties that own those devices.



© 2019 Blockchain Research Institute. All rights reserved.



- » Exchanging digital assets, especially where auditability is essential, including making payments in digital currency or in tokens that serve as the unit of exchange in a specific blockchain system, as ether does in the Ethereum blockchain.
- » Ensuring that project participants behave in a manner that benefits all stakeholders, especially when participants do not know each other and have no other reason to trust each other outside the blockchain environment.
- » Building a shared incentive and reputation management system where the performance of employees, contractors, and suppliers is visible to the project ecosystem.
- » Executing smart contracts, which are distributed applications that execute the terms of business agreements as conditions are met and validated.

Disrupting project management: PMOs in transition

The PMO is an organizational structure that standardizes project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.¹⁰ It integrates data and information from organizational projects and evaluates how the organization is fulfilling these higher-level strategic objectives.¹¹ Its core functions can vary, but most often include project governance, performance measurement, resource allocation, schedule management, financial management, risk management, and project communications.

The PMO is an organizational structure that standardizes project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.

In organizations with high-performing PMOs, the PMO often plays a vital role in bridging the gap between strategy design, project execution, and value delivery. As the Project Management Institute (PMI) noted in its “2018 Pulse of the Profession” survey, “Some organizations want to be more efficient, while others are trying to increase margins or drive innovation. Regardless of the benefits they seek, organizations use projects to achieve their strategic objectives. Project managers in those organizations are turning ideas into reality.”¹²

PMOs seeking to maintain their currency in their organizations know that it is no longer enough to master the fundamentals of project management. They need to aim higher. As Bill Mabry, director of the digital transformation PMO at Salesforce put it: “PMOs need to be seen as transformational and leading edge rather than a support system or an administrative body.” Mabry continued, “The smart ones are repurposing to align to customer experiences and ensuring that the vision, the means of achieving it, and all of its success



Before examining how blockchain can help revolutionize project management, we look at how these trends are reshaping the PMO function.

metrics align with and support the broader business strategy.”¹³ In other words, leading PMOs understand that in today’s disruptive landscape an organization’s success depends on both an effective and dynamic strategy, as well as a creative and resilient execution of that strategy by an empowered PMO.

This gravitation toward strategy execution is one of a handful of key forces converging to disrupt the traditional PMO model. The rise of disruptive technologies, the relentless focus on continuous innovation, and the shift to highly networked models of value creation and value delivery are forcing a fundamental shakeup of how companies compete, which in turn is spurring PMOs to recalibrate the value they provide to their organizations.

Before examining how blockchain can help revolutionize project management, we look at how these trends are reshaping the PMO function.

Networked corporations and decentralized organizations

The traditional vertically integrated corporation is a paradoxical beast. Capitalist titans such as Henry Ford champion the marketplace’s virtues, yet their corporations function like planned economies, often taking over public sector markets such as healthcare and education.¹⁴

For decades, these corporate fortresses triumphed over competitors, but no longer. The monolithic, vertically integrated companies have morphed into more agile competitors. In a recent Brightline Initiative survey of over 1,600 executives worldwide, the consensus view was that, to combat siloed ways of working, organizations need to set up processes and create incentives that encourage and reward collaboration across organizational boundaries. Executives generally agreed that decentralized decision-making generates timely and powerful market insights from managers on the front line who are navigating changing market conditions.¹⁵

Start-ups are going global and using technology to access international markets and international talent pools with a minimum of bureaucracy, financing, and overhead.

Smart companies are breaking down silos between functions, business units, and offices in different countries, deploying resources and capabilities globally, and harnessing the power of human capital across borders and organizational boundaries. For the managers in charge of coordinating these sprawling webs of value creation, the strategic role of project management is less about producing schedules, spreadsheets and status reports, and more about mobilizing and coordinating knowledge, people, resources, and capabilities within intricate business webs.

Start-ups and small companies are going global, too, and using technology to access international markets and international talent pools with a minimum of bureaucracy, financing, and overhead. Gone are the days when entrepreneurs had to build up their business infrastructure painstakingly from scratch. Aided by Internet-based



Perceptive business owners can manufacture and distribute entirely new product lines without having to own a physical plant or manage inventory.

business platforms, small to medium enterprises can now go global from day one, reaching overseas markets and talent pools with a few clicks.¹⁶ Modern collaboration technologies not only put a much larger and more diverse talent pool within reach of any entrepreneur starting or scaling a business; they allow talented individuals to work together in a seamless, global operation, despite being separated by time zones and geography.¹⁷ Perceptive business owners can even manufacture and distribute entirely new product lines without having to own a physical plant or manage inventory.

How do project managers track the flows of information and resources in companies that look radically different from the quintessential organizational hierarchies of yesteryear?¹⁸ A quick look at the project management practices of ConsenSys, a born-global blockchain start-up, provides a clue.

ConsenSys was one of the first Ethereum software development companies and is today a prominent blockchain advisory and development firm. Founded in 2015 by Joseph Lubin in Brooklyn, New York, the company grew to over 1,100 employees at the peak of the crypto boom, all distributed globally. ConsenSys uses blockchain in its day-to-day activities and management, including software development and testing, hiring and outsourcing, compensation and funding, and project management.

Project teams are highly self-organizing and the company's modus operandi, according to Lubin, is to be as "flat, decentralized, and fluid as we can be."¹⁹ Members (its term for employees) "identify the work to be done, distribute the load among the people eager and able to do it, agree on their roles, responsibilities, and compensation," and then codify these arrangements in explicit and detailed agreements, some of them structured as smart contracts on the Ethereum blockchain.²⁰ Performance is transparent to all. Lubin said, "This leaves us free to communicate, be creative, and adapt based on these expectations."²¹

Both accountability and collaboration are incentivized through member ownership. Everyone owns a piece of every project directly or indirectly, and this syndicates trust in the community: "Persona and reputation systems will keep us more honest and well behaved toward each other."²²

Both accountability and collaboration are incentivized through member ownership.

ConsenSys is a decentralized organization that manages not only projects but also the firm itself on the Ethereum blockchain. It is a preview of how companies can harness distributed ledgers to implement decentralized management models. The company is small: its employees are located around the world but associated with a dozen regional hubs. They are experimenting with internal markets among the hubs and decentralized development team "spokes," where token bounties are issued to allow outside collaborators (i.e., free agents, independent contractors) to work on ConsenSys projects. Bryan Peters, a leader in the Waterloo hub in Canada, explains the evolution of the ConsenSys approach:



Our management and scaling practices are inspired by the blockchain. We've decentralized management and decision-making processes and are now experimenting with codifying that into smart contracts on the blockchain. We've taken the philosophy of the technology and applied it to how we manage ourselves.²³

Disruptive technologies

Technology is radically reshaping the economic landscape, and its relentless progression is a challenge for even the most sophisticated firms. One of the most notable things about the digital revolution is not only how much it has transformed how we work, learn, and create but also how fast the underlying technologies and associated applications are evolving. Today, there are possibilities for digital disruption across all sectors—from agriculture and automotive to education and healthcare—and across many technological domains, including virtual reality, big data, robotics, artificial intelligence, and blockchain. PMOs must not only help their organizations adapt to these new realities, they must also apply disruptive technologies to how they work. Consider a few examples.

PMOs must not only help their organizations adapt to new realities, they must also apply disruptive technologies to how they work.

Sped by the exponential rate of technological progress, powerful artificial intelligence, and increasingly versatile robots are combining to create a new era of superintelligence that will reshape the social and economic landscape. From robotic surgery to autonomous vehicles and revolutionary biotech automation, the applications for increasingly smart machines will span healthcare, legal, and financial services, transportation, construction, agriculture, manufacturing, and how work gets done.

AI systems are moving beyond high-volume, low-complexity data management and analytics to execute increasingly non-routine and complex processes that have traditionally required the unique pattern recognition capabilities associated with human cognition. Increasingly



Human Observer Exhibition Photo Montage Faces by Gerd Altmann (geralt), 2017, used under Pixabay license, accessed 9 May 2019.



PMOs could position themselves to harness AI capabilities to help automate and re-engineer business processes for greater efficiency and impact.

sophisticated systems for speech recognition, natural language understanding, and image classification, for example, are making computers capable of recognizing patterns and understanding meaning in big data.

Already, computers can do such information-based tasks as administrative support, basic information brokering, simple software coding, boilerplate legal work, and even financial analysis and stock trading. Perhaps of greatest interest to PMOs, however, are new AI systems like Quill, a natural language generation platform that can collect and analyze data and then apply a narrative structure to suit any audience.²⁴ Quill is perfectly capable of writing a corporate financial report or a project status update, without any human editing. It can do the same with workflow reporting or business intelligence, just about anything that involves data, analysis, and reporting.

PMOs could position themselves to harness AI capabilities to help automate and re-engineer business processes for greater efficiency and impact. Administrative duties like scheduling meetings and other project governance and accounting functions could use intelligent agents to automate or heavily streamline tasks that are rules-based, routine, and repetitive. The promise is that AI-based applications can reduce backlogs, overcome resource constraints, free project managers from mundane tasks and liberate personnel for more complicated and value-added endeavors. For example, Deloitte's Center for Government Insights "conservatively" estimates that assigning administrative and data management tasks to today's AI systems could free up 96.7 million federal government working hours annually in the United States (out of 4.3 billion working hours total), potentially saving \$3.3 billion. With greater investment, the authors estimate that AI technology could eventually free up as many as 1.2 billion working hours every year, saving \$41.1 billion.²⁵

PMOs can increase their organizational relevance by helping to lead the way in the adoption, expansion, and implementation of disruptive technologies in their organizations.

As this report argues, blockchain promises equally profound disruptions for project management. PMOs should count on seeing a rapid acceleration of digital innovation that will unleash wave after wave of creative destruction and open up new possibilities for products and services that we can barely imagine today.

Whether artificial intelligence, blockchain, or the Internet of Things (IoT), PMOs can increase their organizational relevance by helping to lead the way in the adoption, expansion, and implementation of disruptive technologies in their organizations. A recent survey conducted by the Project Management Institute found that a majority of PMO leaders recognize this new imperative, with 66 percent of the 529 PMO directors surveyed indicating that disruptive technologies are affecting their PMO and, furthermore, that the impact is being felt not only on project deliverables but also on how PMOs get things done.²⁶

Faster clock speeds and continuous innovation

Organizations are embracing continuous change, based on the capacity to sense and respond instantly to customer needs and



Just one in five organizations have effective feedback loops to use all the information in strategy delivery.

emerging competitive threats. They are evolving their practices to meet the digital challenges faced by all industries and regions, and they will continue to rely on project success as a competitive advantage to drive their organizations relentlessly forward.

In one research study, the Brightline Initiative found that most companies monitor key customer and competitor trends that are likely to affect strategy; however, just one in five organizations have effective feedback loops to use all the information in strategy delivery.²⁷

High-performing PMOs can support the capacity for continuous innovation and transformation by helping organizations accelerate the pace at which they move from strategy design to delivery. As the Project Management Institute argues, "Organizations that fail to develop a competency that allows quick response to significant change will not survive. Technology is leveling the playing field, empowering start-ups to enter—and shake up—the market faster, while pushing incumbents to drive continuous innovation to quickly capitalize on opportunities and maintain a competitive edge."²⁸



Metro Subway Train Station Transportation City by Free-Photos, 2016, used under Pixabay license, accessed 9 May 2019.

Visa's marketing organization is a case in point. The global payments industry is evolving at breakneck pace and new competitive threats are emerging to disrupt incumbents like Visa. Visa needed to increase its innovation clock speed in response to new offerings such as Apple Pay and Google Pay and new cryptocurrencies like bitcoin. It did so by shifting from a vertical departmental structure to a horizontal and project-based approach. "We had to make the organization flatter and more fluid," said Lara Balazs, senior vice president and head of North America Marketing, in a 2015 *Harvard*



Project managers will need more than just technical skills to support their organization's transformation initiatives in this environment.

Business Review report.²⁹ "To do that, we moved to a model where people of different backgrounds move from project to project in a very fluid and agile way."

Visa's marketing teams, for example, include expertise in marketing operations, digital content, analytics, traditional media, and online communities. The marketing teams work closely with product development and operational teams to ensure seamless execution of plans. As Balazs put it: "Horizontally connected teams drive speed, agility, and nimbleness."³⁰

Leadership skills and strong business acumen are basic requirements. That's just a start. Project managers will need more than just technical skills to support their organization's transformation initiatives in this environment. They must be equipped to:

- » Sense and respond to change
- » Internalize and champion their organization's strategic objectives
- » Stay on top of emerging technologies, market, and customer trends
- » Understand how the projects they manage are positioning their organization to be more competitive in today's marketplace

As Jamal Farhat, vice president and CIO of BorgWarner—a manufacturer of powertrain components—explained, "For us, our project managers act not only as implementers, but also as internal consultants. Part of the role they play is to explore the business case, to determine the economic value being created, and to transform proposed technologies into feasible initiatives and projects."³¹

Blockchain and the PMO: A new platform for managing complex projects

Blockchain is indisputably one of the most disruptive forces of the past decade.

Having enabled the rise of new cryptocurrencies, blockchain is indisputably one of the most disruptive forces of the past decade. Yet, its disruptive potential is reaching far beyond the realm of bitcoin. From global financial markets to healthcare delivery, blockchain is fundamentally changing how we collect, manage, and record information. In sector after sector, blockchain is simplifying complex ecosystems, creating trusted and secure repositories of data, and introducing new opportunities to leverage complementary technologies such as smart contracts and artificial intelligence.



Can the same distributed ledger technology that powers bitcoin also enable better execution of strategic plans and projects?

Blockchain's power to record, enable, and secure huge numbers and varieties of transactions raises an intriguing question: can the same distributed ledger technology that powers bitcoin also enable better execution of strategic plans and projects? The Brightline Initiative and Blockchain Research Institute believe the answer is an unqualified yes.

Blockchain is already changing how organizations carry out trusted transactions, and it will just as surely transform how organizations manage projects. A core function for any project management office, after all, is to maintain an ongoing record of project-related transactions. With those records, project managers can track an organization's actions and performance, and they can guide planning. The records provide a view not only of how the organization works internally but also of the organization's outside relationships with its suppliers, partners, customers, and investors.

In a recent issue of *Harvard Business Review*, Marco Iansiti and Karim R. Lakhani argue that these fundamental building blocks of the modern corporation are ripe for disruption by blockchain. They wrote:

Contracts, transactions, and the records of them are among the defining structures in our economic, legal, and political systems. ... And yet these critical tools and the bureaucracies formed to manage them have not kept up with the economy's digital transformation. They're like a rush-hour gridlock trapping a Formula 1 race car.³²

With blockchain, a new landscape is emerging in which contracts and transactions are embedded in digital code and stored in transparent, shared databases, where they are protected from tampering and



Auto Racing Fast Formula 1 Haystack Person Race by Pexels, 2016, used under Pixabay license, accessed 9 May 2019.



Blockchain technologies are creating strategic opportunities to streamline and automate tasks that would otherwise involve hours of paperwork processing for project managers.

deletion. As Iansiti and Lakhani put it, “Every agreement, every process, every task, and every payment could have a digital record and signature that could be identified, validated, stored, and shared.”³³

Blockchain technologies, in short, are creating strategic opportunities to streamline and automate tasks that would otherwise involve hours of paperwork processing for project managers. Self-executing contracts can define the rules and penalties around agreements for project deliverables, keeping participants on task. Distributed ledgers can help project managers cut down on time-consuming status reporting by providing project participants with a shared, real-time view of all significant project activities.

The Project Management Institute has argued that value-adding and high-performing PMOs must transition from passive entities that manage scope, costs, and schedules to active, adaptive partners that lead and execute strategic initiatives. Blockchain is a powerful technology that can help PMOs realize this ambition. However, because blockchain is uncharted territory for many organizations, we shall delve into the fundamental characteristics of distributed ledgers and how these characteristics can enable new models of project management.

Blockchain pilots in project management

The essence of good project management boils down to shepherding effective execution of organizational plans and strategies. That means taking a high-level strategic objective, distilling it down to discrete tasks, and managing these tasks to a successful conclusion. High-performing PMOs, however, go well beyond elementary task management. They support organizational change management by identifying work processes that must be faster or more effective, and they use advances in technology to inject greater speed, agility, and effectiveness into their organization’s implementation efforts.

High-performing PMOs support organizational change management by identifying work processes that must be faster or more effective.

How are PMOs adapting to these new demands? Which role will blockchain play in making PMOs more successful in bridging the gap between strategy design and delivery? Our case studies shed light on these questions by featuring blockchain-enabled project management use cases in three different industries:

- » **Blockchain-enabled clinical trials.** The first case examines how the pharmaceutical industry is gearing up to use blockchain to modernize and accelerate the clinical trials process. For PMOs, the case highlights an application of blockchain within a complex project environment where trust and verifiability are paramount concerns for patients, scientific researchers, regulators, and drug companies.



In the pharmaceutical industry, the clinical trials process provides a compelling use case for exploring the transformative potential of blockchain.

- » **Smart contracts and construction.** The second case demonstrates how blockchain-enabled project management can inject transactional discipline, clear communication, and trust into large and complex construction projects. The case highlights how PMOs can automate the contractual processes and paperwork underpinning complex projects to save money, free up valuable resources, and speed up project delivery.
- » **Traceability in the global supply chain for food.** The third case dissects a cutting-edge blockchain pilot deployed by Walmart and IBM to bring greater transparency and traceability to the global food system. A systematic breakdown of the pilot implementation approach provides PMOs with valuable insights into how to manage strategic projects that span vast global supply chains.

Blockchain-enabled clinical trials: Cutting through project complexity

Getting better at project execution is important across all sectors. However, there is arguably no other sector where the challenges of project execution are felt more acutely than in the pharmaceutical industry, where the need to streamline the process of developing and testing new medical therapies is a perennial challenge with massive consequences for the organizations, governments, and society. The clinical trials process provides a compelling use case for exploring the transformative potential of blockchain and gaining insight into the roles PMOs can play in streamlining complex projects.

Large clinical trials of medical therapies represent a very complex project type with many moving parts. Distributed activities, often over extended times and multiple geographies, must be conducted and documented with precision. And yet, these complex undertakings are often fraught with problems: from errors in data capture and challenges enrolling patients, to bias inherent in the methods and the skewing of analyses (often through selective reporting) to get the hoped-for results. The results are difficult to evaluate and reproduce, extending the duration and cost of trials. About 80 percent of trials are not reproducible.³⁴ According to Ken Getz of the Center for the Study of Drug Development at Tufts University, close to 90 percent of the drugs that enter clinical testing fail to receive regulatory approval.³⁵ The cost and complexity of drug development, coupled with the high failure rate, makes the average cost of successfully developing a single drug about \$2.6 billion.

The cost and complexity of drug development, coupled with the high failure rate, makes the average cost of successfully developing a single drug about \$2.6 billion.

Setting aside competitive rivalries to solve the clinical trials problem

With the cost and complexity of clinical research on the rise, some of the largest players in the pharmaceutical industry—including Amgen, Bristol-Myers Squibb, Pfizer, and Sanofi—have set aside their competitive rivalries to investigate how blockchain can modernize





Test Tube Lab Medical Research Drug Water by PublicDomainPictures, 2013, used under Pixabay license, accessed 9 May 2019.

and accelerate the clinical trials process.³⁶ If these pharma giants agree on one thing, it is that improved data management holds the key to reducing the length and cost of clinical trials and improving their success rate.

“The issue that we all struggle with in pharma is ... the fact that data is fragmented,” said Munther Baara, senior director of business technology at Pfizer, who heads up the company’s efforts to launch a new paradigm for clinical research. “If you see five different physicians, you end up with data stored in five different systems.”³⁷ These proprietary data silos limit the interoperability and transferability of medical data, which makes it challenging to aggregate data for research purposes and impedes efforts to locate and recruit individuals who meet the eligibility criteria for a given trial.

If the pharma giants agree on one thing, it is that improved data management holds the key to reducing the length and cost of clinical trials and improving their success rate.

While there are not yet any blockchain-based project management systems for clinical trials in operation that we know of, an extensive use case developed by researchers at the Centre of Research in Epidemiology and Statistics at the Sorbonne Paris Cité demonstrates an array of compelling applications. In their 2017 research paper, Mehdi Benchoufi and Philippe Ravaud document how blockchain can improve the trials process and mitigate the common problems in managing it to successful conclusion.³⁸ Their thesis states:

Reproducibility, data sharing, personal data privacy concerns and patient enrolment in clinical trials are huge medical challenges for contemporary clinical research. ... Blockchain can have a global impact on clinical research because it allows for tracking, sharing and caring for data. ... Blockchain technology can be considered a basis for improved clinical research methodology and a step toward better transparency



to improve trust within research communities and between research and patient communities.³⁹

As a starting point, the researchers mapped the complex workflow of clinical trials—across 14 stakeholders and eight main trials phases—that they could encode in blockchain. These are the key stakeholders:

While each stakeholder has different needs and functions, they all want clinical trial data to be secure, immutable, and managed with the highest integrity.

- » Sponsors who want the trials conducted as designed
- » Regulators who need to evaluate the results
- » Patients who volunteer to participate and want their privacy protected
- » Scientific community members who want to be able to reproduce, analyze, and extend the research

While each stakeholder has different needs and functions, they all want clinical trial data to be secure, immutable, and managed with the highest integrity. The key data to manage throughout the research process include the upfront data-sharing plan and schedule, clinical trial protocols, patient consents, and results in real time. Stakeholders can also capture and share the analytical code that processes the results to prevent analytical errors and promote reproducibility.

When the key data are certified, timestamped, and preserved in their entirety on a blockchain, research is easier to reproduce and validate. Any falsification of results is harder to obscure. Smart contracts can be a means of chaining together clinical trial steps; each step is linked to its predecessor, and stakeholders can trace and verify that the designed methodology has been followed in its entirety.

"Audit trails provide this insight, and blockchain can take it to the next level by improving privacy, security, and transparency."

 **DANY DEGRAVE**
Senior Director of Innovation Programs and External Networks
Sanofi Pasteur

Dany DeGrave, senior director of innovation programs and external networks at Sanofi Pasteur, suggests that the immutable nature of blockchains would not only guard against the falsification of results, it could also encourage patients, regulators, and other researchers to place greater trust in the systems being used to track personal health data.⁴⁰ Mike Novotny, CEO of Medrio, which delivers software solutions for clinical researchers, also sees the potential for blockchain to underpin more effective research practices. "Good clinical practice requires as much transparency as possible regarding where and when data was entered, and by whom—as well as other information such as who has permission to access what data," said Novotny. "Audit trails provide this insight, and blockchain can take it to the next level by improving privacy, security, and transparency."⁴¹

A distributed ledger for health informatics

Blockchain could also help address another common clinical research problem: the challenging process of enrolling qualified patients into



The frequent need to prolong the duration of studies is a key driver of escalating drug development costs.

clinical trials. The US-based National Cancer Institute estimates, for example, that fewer than five percent of eligible adult cancer patients participate in clinical trials, even though 70 percent of Americans are estimated to be inclined or very willing to participate in such research.⁴² One reason is that the current recruiting approach is labor intensive and often involves hiring contract research organizations to visit physicians' offices to find patients who qualify and are interested in participating in a study—a process insiders call “beating the bushes.” Under-enrollment in clinical studies is a growing concern for medical researchers. The frequent need to prolong the duration of studies is also a key driver of escalating drug development costs.⁴³

That a significant majority of people are willing to share their medical information for a good purpose, if they can maintain their privacy and security, suggests a powerful role for blockchain. For example, Baara of Pfizer envisions a scenario where a distributed ledger for health informatics could allow individual patients to store their medical data anonymously, thereby making it visible to trial recruiters, who could then reach out to consenting patients if their data qualifies them for the clinical trial. “The beauty with the blockchain is [that] the control is with the individual,” he said.⁴⁴

Unfortunately, the challenges for clinical researchers don't end, when people are enrolled in a clinical study. The collection of informed patient consent also is error-prone and incomplete, especially when consent needs to be renewed because protocols change. Benchoufi and Ravaud prototyped a procedure for timestamping each completed consent and revision on the blockchain, creating a master document that “represents a secure, robust proof of existence of the whole consent-collection process.”⁴⁵

The long-term vision of blockchain in healthcare extends far beyond the management of clinical trials. Benchoufi and Ravaud foresee a future state where blockchain leads “to the structuration of some kind of community-driven Internet of health data, gathering researchers and patient communities, social networks and Internet of Things data flows,” into a seamless environment for wellness promotion and medical research.⁴⁶ Blockchain could also enable better digital rights management in medical research, such as enforcing rules about who owns and can see DNA data. For example, IBM is working with the US Food and Drug Administration (FDA) on a blockchain-based method to manage large file transmissions, where the data must be divided. Blockchain provides the cipher and permissioning system to maintain the integrity of the reassembled files.⁴⁷

Blockchain provides the cipher and permissioning system to maintain the integrity of the reassembled files.


Insights for PMOs on data infrastructure

In the end, what matters most to the pharmaceutical industry is that a blockchain-enabled clinical trial's process can deliver successful drug approvals with greater efficiency and less cost. Amgen, Bristol-Myers Squibb, Pfizer, Sanofi, and others in the industry recognize



that data immutability, transparency, auditability, and trust can all play prominent roles in obtaining FDA approval. They also see the potential to establish more reliable trial data and prevent its misuse, including the misstatement of results to meet performance expectations. Together these benefits from blockchain integration can improve accuracy, efficiency, and effectiveness in the clinical trials process.

"These are areas in which a purely market-driven approach is sub-optimal and where the sharing of information makes a great deal of sense."

 **ALED EDWARDS**
CEO
Structural Genomics
Consortium

More broadly, blockchain-enabled clinical data repositories could help enable large-scale medical and pharmaceutical research efforts to co-develop early stage technology tools, establish data standards, share disease target information, or pursue other forms of collaboration that could lift the productivity of the entire industry. Aled Edwards has seen the benefits of such collaborations firsthand in his role as CEO of the Structural Genomics Consortium, a global biomedical research collaboration involving scientists in hundreds of universities around the world and in nine global pharmaceutical companies. Edwards cites a range of industry problems where more collaboration between big pharma, biotech firms, and university researchers would yield better results: antibacterial research, developing more intelligent approaches assessing drug toxicology, reducing the industry's reliance on animal testing, and even tackling grand medical challenges like cancer, diabetes, and Alzheimer's. "These are areas in which a purely market-driven approach is sub-optimal and where the sharing of information makes a great deal of sense," he said.⁴⁸

For PMOs, the clinical trials use case is interesting because it shows how blockchain can provide the data infrastructure for managing complex projects with multiple stakeholders where trust and verifiability are paramount. As Jerry Cuomo, vice president of



Medic Hospital Laboratory Medical Health Doctor by Darko Stojanovic (DarkoStojanovic), 2014, used under Pixabay license, accessed 9 May 2019.

Effective project management depends upon clear audit trails and having a fast, easy, and transparent way to locate and share large quantities of data with specific individuals, often across long distances.

New wearables like smart safety glasses and programmable clothing can improve productivity and increase worker safety.

blockchain technologies at IBM, explained, “All parties have a view into their common state, in real time and without filtering. All can see the current view of the project, or their part of it, with a high degree of certainty that nobody is gaming the system.”⁴⁹ So much of effective project management, as Cuomo points out, depends upon clear audit trails and having a fast, easy, and transparent way to locate and share large quantities of data with specific individuals, often across long distances.

Smarter construction: The potential of smart contracts for PMOs

At first glance, the construction industry seems like an unlikely place to look for blockchain-enabled innovation in project management. As compared to industries such as software and consumer electronics, innovation cycles in the construction sector are sclerotic and the industry as a whole has been slow to adopt new technologies. The waves of digital upheaval and disruption seen in other sectors have bypassed what construction insiders describe as a conservative industry that is reticent to adopt unproven methods. A recent study by Boston Consulting Group found that digital technologies could boost the construction sector’s percentage plan complete by eight to ten percent.⁵⁰ Instead, the overall infrastructure and urban development industry’s productivity has failed to keep pace with overall economic output over the past 40 years.⁵¹

In a sector where cost and schedule overruns are the norm, there is growing recognition that construction is ripe for digital disruption.⁵² Augmented reality applications, for example, could overlay digital blueprints onto physical spaces and allow users to point their phone or tablet at a building component to retrieve detailed digital specs.⁵³ New wearables like smart safety glasses and programmable clothing can improve productivity and increase worker safety.⁵⁴ With project management, industry leaders see an opportunity for blockchain-based solutions to help instill transactional discipline, clear communication, and trust among parties in large and complex development projects.

Construction often brings together large teams of contractors and subcontractors to design and shape the built environment. Invariably, large commercial projects must comply with an abundance of building codes, safety regulations, and standards: commercial developers and contractors must frequently verify that their work is compliant. Using blockchain to automate the contractual processes and paperwork could save money, free up valuable resources, and speed up project delivery.


While this sounds good in theory, spotting instances of blockchain adoption in construction has been difficult until very recently. “Stakeholders in the engineering, construction, and infrastructure sector were highly siloed and very competitive. Making money was the preeminent driver,” said David Bowcott, global director of growth, innovation, and insight at Aon. “Increasingly, we are thinking more carefully about when and where we need to compete and what can





Site Engineer Construction Machinery by 11066063, 2019, used under Pixabay license, accessed 9 May 2019.

"There are huge megatrends that are reshaping our sector; and, thanks to the Internet of Things, we have unprecedented access to new data streams that can feed into predictive analytics and help us probe the future."

 **DAVID BOWCOTT**
Global Director of Growth,
Innovation, and Insight
Aon

we share and collaborate on. There are huge megatrends that are reshaping our sector; and, thanks to the Internet of Things, we have unprecedented access to new data streams that can feed into predictive analytics and help us probe the future."⁵⁵

Some early use cases are showing the way forward, including one project led by Propulsion Consulting and HerenBouw, a large commercial real estate developer in Amsterdam that is leading a large-scale development in the Amsterdam harbor.

Blockchain-enabled project management in real estate development

According to Propulsion Consulting founder Marc Minnee, HerenBouw's objective was to set up a blockchain-enabled project management system to make the building development lifecycle more efficient. The blockchain application built by Minnee focused on registering transactions at legally binding moments, where accuracy is essential and an audit trail is most important.⁵⁶ These activities include contracts, work approvals, invoices and their approval, payments, and sometimes initiation of subsequent transactions. Integrating blockchain into contractual obligations, for example, will automate certain actions, such as contractor payment when a contractor has reached an agreed construction milestone and added evidence of this milestone to the shared ledger.

The blockchain system developed by Minnee centers on the interactions between real estate developers, contractors, and their subcontractors. Permissions are carefully structured because contractors do not want their arrangements with developers known to their subcontractors, or to have one subcontractor's arrangements



"Blockchain provides a platform for clearly cascading work products down the chain and for holding everyone accountable for completing key tasks."

 **MARC MINNEE**
 Founder
 Propulsion Consulting

The system's benefits also develop more trust, which is the foundation for reducing friction in their mutual business processes.

known to others. Contracted work is broken down into tasks, and smart contracts are structured to govern the execution of key tasks.

Minnee and HerenBouw also envisioned building a reputational ledger that would use the digital IDs of contractors and vendors to track the quality and timeliness of contracted deliverables over time. This identification and reputation system was designed to help building owners and contractors source qualified tradespeople and subcontractors quickly, and make it easier for people who don't know or trust each other to do business together. However, reticence of local tradespeople to participate in the reputation system meant that HerenBouw had to shelve this aspect of the blockchain solution temporarily.⁵⁷

Nevertheless, Minnee makes a compelling case that the end-to-end process of a complex construction project (from design and planning through to construction and handover) is more manageable when all important actions are represented as one-to-one contracts, reputations are visible, and accountabilities are clear.⁵⁸ "Blockchain provides a platform for clearly cascading work products down the chain and for holding everyone accountable for completing key tasks," Minnee said.

One challenge, according to Minnee, is that the blockchain-enabled approach places more pressure on the upfront structuring of work and contracts, while also posing a risk of rigidity. Too much automation of smart contracts, for example, can impede the project manager's ability to adapt to changing circumstances that are hard to encapsulate in computer code: acts of nature, changes in building codes, or on-site accidents that cause work stoppages. Therefore, contract design needs to anticipate the terms and conditions under which parties can alter their contracts.

Operationally, the system's benefits include timely information, unambiguous communication, and fewer mistakes. As Minnee said, "Stakeholders have a clear and evenly distributed incentive to register these facts on-chain: either you won't get what you ordered or you won't get paid."⁵⁹ They also develop more trust, which is the foundation for reducing friction in their mutual business processes. With less time spent on project overhead, "Stakeholders spend more time discussing creative design and building method options," he said.⁶⁰

Blockchain pilots in construction achieve liftoff

HerenBouw's blockchain push in commercial real estate development is just one in a series of blockchain-enabled pilots and projects around the world. In another recent example, Briq—a California-based blockchain firm specializing in construction solutions—is demonstrating the potential to capture and secure all of a construction project's documentation in a blockchain ledger that parties could navigate and turn over to the owner as a deliverable at handover.



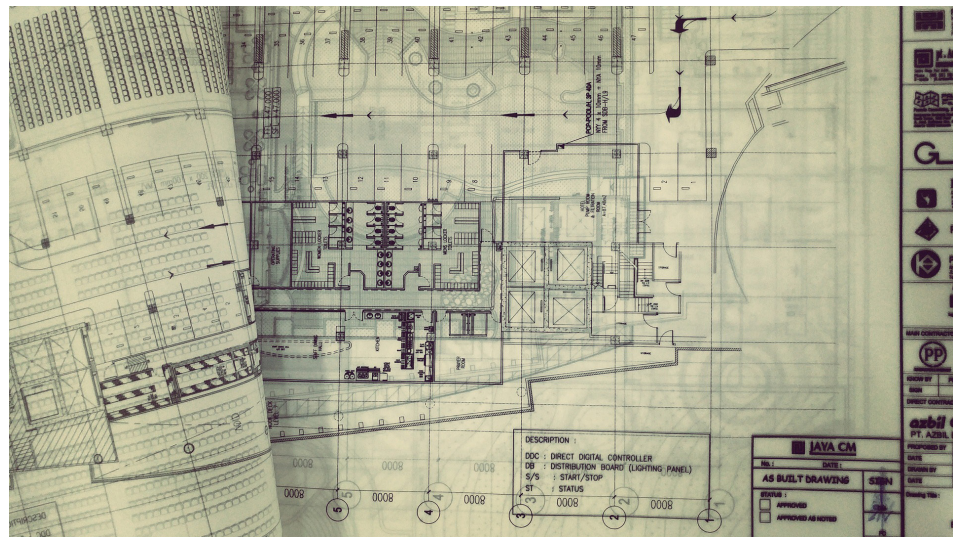
Working on behalf of Minneapolis-based Gardner Builders, Briq developed a “digital twin” of a new office construction that includes a room-by-room inventory of every installed asset. The blockchain-encoded specifications for the construction assets are granular, down to paint colors, ceiling fixtures, LED bulbs, and door hardware, along with the manuals and warranty information and service life in a countdown clock that building owners can monitor.

Aon, a global risk advisor to the construction industry, estimates that 95 percent of building construction data currently gets lost on handover to the first owner.

Aon, a global risk advisor to the construction industry, estimates that 95 percent of building construction data currently gets lost on handover to the first owner.⁶¹ Using blockchain to chronicle the end-to-end building process creates an incredibly powerful data repository for the entire lifespan of the building. “When a product or specification needs to be found in a building,” said Briq CEO, Bassem Hamdy, “there is finally a place to go to simply search for what is actually in that building.”⁶² As construction goes high-tech, with advanced digital systems to regulate heating and lighting, such repositories will be increasingly valuable.

One advantage of Briq’s digital twin is the ability of building owners to update and append it over time. “Any improvements and refurbishments to the building can be documented, and the whole repository can be transferred to new owners if the asset is put up [for] sale,” said Ellis Talton, Briq’s director of growth marketing.⁶³ In other words, building owners get a living and breathing ledger of everything that has happened with the building.

In addition to its work with Gardner Builders, Briq has partnered with Probuild, one of Australia’s largest building firms, to reinvent how the firm tracks construction assets and manages its global supply chain.⁶⁴ The Construction Blockchain Consortium, which includes some of the United Kingdom’s largest construction players, was launched in 2016 by the University College London to transfer knowledge, build proofs of concepts, and track the adoption of blockchain and artificial intelligence in construction.⁶⁵ In the Middle East, Dubai



Construction Drawing Engineering Architect Builder by LATUPEIRISSA (pisauikan), 2017, used under Pixabay license, accessed 9 May 2019.



Land Development is seeking to eliminate paper documents and implement a smart contract infrastructure to automate contracting within the real estate development sector.⁶⁶ This growing cohort of early adopters suggests that the long-awaited digital disruption of construction has finally achieved liftoff.

Insights for PMOs on using smart contracts

Ingrained habits and culture in the construction sector mean that widespread blockchain adoption will take time.

Ingrained habits and culture in the construction sector mean that widespread blockchain adoption will take time. "The construction industry is technologically advanced in many aspects of what it does," said Talton. "But the industry is very relationship based. There are many family-owned firms and private companies. The selection of contractors and subcontractors can be based on relationships that have existed for decades." Large projects also entail big risks, including financial risks, human capital risks, and environmental risks, according to Talton. He said, "Some of the conservatism when it comes to technology adoption is related to the very risky nature of large-scale projects."⁶⁷

PMOs should heed this as a warning that they must be prepared to confront the change management challenges that accompany the implementation of disruptive technologies. In construction, the deployment of distributed ledger technology will require fundamental changes to how entities contract with each other and how they interact with and manage data. Within the industry, people are accustomed to dealing with a lot of paperwork, and while less burdensome solutions will be welcomed, the switch to blockchain-enabled smart contracts will require a significant overhaul of systems and processes. Large engineering and construction firms will have the resources to manage this transition, but as HerenBouw discovered, smaller firms and contractors may be reluctant or unable to make the necessary adjustments.

Construction firms will also need to increase their comfort level with making larger and bolder investments in new technology.

Construction firms will also need to increase their comfort level with making larger and bolder investments in new technology. Talton points out that very little money is invested in the upfront contracting and technology infrastructure for managing complex construction projects. "The vast majority of the projects costs are in the building process, including the people and materials," said Talton. Industry stats bear this out. Spending on information technology today accounts for less than one percent of revenues (versus 3.5 to 4.5 percent for the aerospace and auto sectors), even though a number of new software solutions have been developed for the industry.⁶⁸ Briq's core value proposition is that construction companies can lessen their risks by investing a little more upfront in the technology for managing projects. Said Bowcott of Aon's participation in the soon-to-be-formed Construction Digital Transformation Alliance, "Collectively, we are all better off if we encourage data collaboration and use blockchain and machine learning to help us establish longer-term industry road maps for investments and technologies that can boost productivity and lessen risk."⁶⁹



Using a blockchain system, smart contracts can streamline and automate tasks that would otherwise involve hours of paperwork processing.

Despite these obstacles, Scott Nelson, founder and CEO of Sweetbridge, finds the construction industry a natural for early applications of blockchain-based PMOs:

Projects are well-structured and contract-based. Objectives are clear—be on-time, on-spec, and avoid rework. Classic project management techniques still work, but projects can benefit from a more decentralized and agile approach where transparency is high and parties can be compensated for outcomes as well as work performed.⁷⁰

Pioneering blockchain efforts in the construction sector also underscore some important lessons regarding the power of process automation to free up project managers to perform greater value-adding roles in their organizations. In traditional sectors like construction, the administrative overhead of contracts, work approvals, invoices, and payments is still largely conducted through paper-based processes that are cumbersome and error-prone. Using a blockchain system, smart contracts can streamline and automate tasks that would otherwise involve hours of paperwork processing.

While project managers remain the central point for structuring and approving contracts, their roles shift in other ways. With the benefit of a single source of truth about the most important actions, the project manager spends less time on reconciliation and more time on orchestrating resources and managing the disruptions and risks introduced by changing conditions and events outside the project proper. In other words, the project managers' role becomes less administrative and more strategic, and this creates opportunities for organizations to harness their talents to boost productivity and achieve better project outcomes.

Securing the global food system: New tools for PMOs

Provenance and traceability, in particular, are vexing challenges for a wide range of companies and their supply chains.

Project management often intersects with supply chain management, especially when enterprise efforts to increase growth and profitability involve driving innovations and efficiencies across a supply chain end to end. Whether working on a new product design, new packaging, or new ways to reduce line scrap, collaboration with suppliers and customers is part of how business is done. As supply chains increase in complexity and connection points, project managers will need new tools and new capabilities to manage teams across far-flung geographies, to boost speed and agility in project execution when there are many players, and to navigate regulatory and compliance hurdles in different markets.

Moreover, when it comes to cutting-edge applications of blockchain, PMOs can take inspiration from some of the innovative solutions that have been deployed to address the challenges of managing global supply chains. Provenance and traceability, in particular, are vexing challenges for a wide range of companies and their supply chains. Whether eliminating conflict stones from the global trade in rough diamonds or tracking the offshore manufacturing processes used to assemble iPhones and luxury apparel items, inquisitive consumers want complete visibility into the business practices of even the most



Some of the most advanced supply chain traceability efforts are focused on establishing the authenticity and provenance of food, and for good reason.

distant suppliers. Along with complementary IoT technologies like sensors and radio-frequency identification (RFID), blockchain is helping answer these concerns by providing new tools for tracking goods across extended supply chains, ensuring that what occurs at each point in the chain can be chronologically recorded on a distributed ledger.

Some of the most advanced supply chain traceability efforts are focused on establishing the authenticity and provenance of food, and for good reason. The World Health Organization estimates that almost one in ten people become ill every year from eating contaminated food, with 420,000 dying as a result.⁷¹ One reason is that the global food supply has grown so complex that it has become almost impossible for food producers and retailers to guarantee the provenance of their products. Regulatory investigations seeking to trace contaminated foods back to their origins often take months rather than hours, days, or even weeks.⁷² In the wake of numerous food scandals, food retailers are turning to new technologies to boost their efforts to instill greater trust, traceability, and safety into the global food system.

In addition to showcasing powerful blockchain applications, these initiatives highlight valuable lessons for PMOs. In this case, we focus on a food traceability partnership between Walmart and IBM. The initiative provides a model for blockchain pilots and demonstrates tactical insights for PMOs that will increasingly find themselves called upon to manage strategic projects that span vast global supply chains.

Transparency and traceability in Walmart's supply chain

Until now, supply chain transparency and traceability have been hampered by the Byzantine nature of the global food system.

Until now, supply chain transparency and traceability have been hampered by the Byzantine nature of the global food system. The Food Safety Modernization Act in the United States, for example, only requires companies in the food supply chain to provide "one back, one up" traceability.⁷³ "One back" refers to where the food came from, and "one up" refers to who bought it. In short, when a food poisoning incident occurs, the problem can't be solved quickly because this is a serial or one-step-at-a-time process. Worse, each company in the supply chain has its own system for record-keeping and processes its transactions in separate databases using different data standards. Many participants must dig through paper records to assist in determining the ultimate source of the contamination. Erroneous or incomplete data can further delay investigations. With multi-ingredient foods including materials from a variety of food chains and countries, importers might end up relying on the arcane traceability systems (if any) of other countries up to the point of import.⁷⁴

Now, some of the world's biggest companies, including Walmart and Nestlé, are working with IBM to build a blockchain to remake how the industry tracks food worldwide. Once fully operational, the blockchain solution will make the complete history and current location of any food item along with its accompanying information



(i.e., certifications, test data, temperature data) readily available in seconds.⁷⁵

The data are captured in an immutable and tamper-proof ledger, arming everyone from importers and retail procurement managers to consumers and regulators with a veritable smorgasbord of information.

Walmart will use the technology to tell stakeholders that a particular head of lettuce came from a particular harvest on a particular farm so that, if a consumer gets sick, then government investigators will have a head start on their inquiry. Rather than chasing a paper trail for days, they can get to the source of a tainted head of lettuce within seconds, and that should mean less wasted produce, fewer sick people, and more confidence in the food system.

For meat products like pork, the tracking process begins in the pens—where every pig is smart-tagged with bar codes—and reaches all the way to the supermarket shelf where packaged pork can be traced back to its origins. A combination of RFID, cameras, and various sensors help document the journey at each step in the supply chain—from cameras installed in slaughterhouses to capture the entire production process to shipping trucks equipped with temperature and humidity sensors to ensure the meat arrives at the supermarket under safe conditions.⁷⁶ With global positioning systems, retailers like Walmart can trace the whereabouts of trucks and monitor conditions in each refrigerated container. If conditions exceed established thresholds, the system will send alerts to prompt corrective action.⁷⁷

All these data are captured in an immutable and tamper-proof ledger, arming everyone from importers and retail procurement managers to consumers and regulators with a veritable smorgasbord of information. Blockchain network participants can fetch data about farm origination, batch numbers, food processing methods,



East Frisia Kale Farm Landscape Green Field by Heiner Sollermann (Sollermann), 2002, used under Pixabay license, accessed 9 May 2019.



expiration dates, storage temperatures, shipping details and, for some food products, soil quality, and fertilizers. All these can be uploaded on an e-certificate and linked to the product package via a QR code.

Managing a complex blockchain pilot

Everyone—from retailers to producers to farmers—could use blockchain as a platform for accelerating innovation in the global food system.

While the initial focus is supply chain traceability and food safety, the solutions pursued by giants like Walmart and IBM could easily grow into something much bigger. Blockchain is a platform for recording and sharing information. Increasingly granular data from a growing network of participants will yield ever more powerful insights and possibilities. Data gleaned from the system could be used to streamline distribution, better manage inventory, reduce food waste, and identify other efficiencies. In other words, everyone—from retailers to producers to farmers—could use it as a platform for accelerating innovation in the global food system.

But how did Walmart and IBM orchestrate such a complex effort? What can PMOs learn about designing and implementing blockchain pilots in their organizations?

The first step was identifying a clear value proposition and business case for investment in blockchain. As Frank Yiannas, Walmart's vice president of food safety, put it: Walmart's blockchain solution needed to be "business-driven and technology-enabled."⁷⁸ For Yiannas, that value proposition was clear. Walmart's need for traceability arose from its focus on food safety and its need to safeguard its corporate reputation and brand. Both require Walmart to be able to prevent or respond quickly to contamination, fruit and animal disease, harmful drug or pesticide residues, or attempted bioterrorism incidents. A blockchain-enabled solution also promised to help the retail giant identify new efficiencies in the supply chain, lower its costs, and increase its margins by reducing food spoilage and costly mass recalls.⁷⁹

The second step was to ensure that there was also compelling value proposition for all participants in the supply chain.

The second step was to ensure that there was also compelling value proposition for all participants in the supply chain. The success of Walmart's food traceability initiative depended on the willing participation of a disparate group of players ranging from breeders and farmers, food processing plants, cold storage facilities, wholesale distribution centers and transport operators, and more. Granting access to the blockchain records ensured that every participant at each step in the food chain could derive clear business benefits from greater supply chain transparency and traceability.

For example, farmers will gain better visibility into international market prices for their goods and enhance their bargaining power accordingly. Food processors will be able to analyze data on the impact of harvest maturity, method of harvesting, food packaging, and modes of transportation on the quality of produce coming into their processing facilities. Transport operators will have access to real-time information about food import quantities in order to optimize their distribution networks. "This is not about competition,



Traceability systems that are integrated with existing company business practices are more likely to be accurate than stand-alone traceability systems.

this is about collaboration,” said Yiannas. “[It’s about] creating solutions that offer shared value for stakeholders.”⁸⁰

Third, Walmart worked with IBM to identify a technology platform that could integrate well with its existing supply chain operations. Brigid McDermott, IBM’s vice president of blockchain business development, said Walmart chose IBM’s blockchain solution because it was “not recreating supply chain, but leveraging existing technologies [such as sensors and global positioning] to enhance supply chain traceability using Hyperledger.”⁸¹ Traceability systems that are integrated with existing company business practices are more likely to be maintained, according to McDermott, and more likely to be accurate than stand-alone traceability systems.

Fourth, Walmart and IBM worked together to build an incremental approach to testing and refining new solutions for increasing food safety. In 2016, for example, Walmart launched a few blockchain pilot projects focused on discrete food items like mangos and pork.⁸² The pilots not only provided a testbed for new technologies and processes, they helped Walmart build confidence in the potential for shared value across the supply chain.

For the system to be truly valuable, Walmart recognized the need for all its suppliers to use it. Requiring them to do so was a big ask, because its supply chain partners came in all shapes and sizes, with different methods of managing data, ranging from paper-based bookkeeping to electronic spreadsheets to enterprise resource planning software. It couldn’t expect all these suppliers to adopt all-new technology, let alone become blockchain experts. So it collaborated with IBM to make blockchain as accessible as possible. According to Walmart spokesperson Molly Blakeman:

*IBM will offer an onboarding system that orients users with the service easily. Think about when you get a new iPhone—the instructions are easy to understand, and you’re quickly up and running. That’s the aim here. Essentially, suppliers will need a smart device and Internet to participate.*⁸³

As its food traceability effort matures, Walmart will continue to experiment, scale, and learn from its blockchain pilots.

As its food traceability effort matures, Walmart will continue to experiment, scale, and learn from its blockchain pilots as it builds coalitions within the supply chain ecosystem where members are seeking to implement blockchain applications more broadly.

Fifth, Walmart built a broad knowledge network around global food safety. The knowledge network gives its partners and collaborators a voice in setting industry standards and conducting research that will support the effective implementation of an industry-wide, blockchain-enabled solution for food safety. To date, the network has brought American and Chinese academics together with Chinese poultry producers to study safety in poultry supply chains.⁸⁴ Walmart has also pooled talent from top academic institutions working on IoT and supply chain analytics solutions—including Massachusetts Institute of Technology, Zhejiang University, and Tsinghua University—to improve the capacity of supply chain participants to predict and detect



areas of greatest vulnerability for food adulteration in global food supply chains.⁸⁵ Walmart said this knowledge network is just getting started and could eventually include other research and development centers, primary production facilities, aggregation and mobilization providers, farm input suppliers, trading and grading participants, wholesalers, retailers, and even customers.⁸⁶



Green Salad Plucking Salad Lettuce Leaves Salad by congerdesign, 2016, used under Pixabay license, accessed 9 May 2019.

Finally, Walmart recognized that early cooperation with governmental regulators would be crucial to its success. The good news was that regulators were enthusiastic about blockchain technology and its potential. A transparent ledger to enhance food traceability aligned with their need for better tools to investigate contamination incidents and monitor the safety of the food supply.⁸⁷ With collaborators in place and a green light from regulators, Walmart was ready to roll out its food traceability platform across the supply chain. One early result is promising: the time taken to track contaminated food to its origin has dropped from approximately seven days to only 2.2 seconds, which minimizes the chance of tainted food ever reaching consumers.⁸⁸ The pharmaceutical industry could benefit from a similar capability in identifying the source of bad batches of drugs.

The pharmaceutical industry could benefit from a similar capability in identifying the source of bad batches of drugs.

Insights for PMOs on global supply chains

For PMOs, Walmart's blockchain-enabled supply chain traceability effort yields a couple of insights. First, PMOs must recognize that the strategic projects they help to execute are less likely to fall within the walls of a single organization. Today's global business networks and processes are so interdependent and interconnected that strategic projects will routinely span an end-to-end supply chain consisting of diverse and distributed participants. Walmart's initiative encompasses quite an assorted cast, ranging from lettuce farmers and Chinese pork producers to international shipping companies and technology giants like IBM. As Walmart learned, the adoption of blockchain also required a step-by-step design and implementation



Project management increasingly means mobilizing knowledge, resources, and capabilities in partnership with a more diverse and globally dispersed network of participants.

process that began with pilot projects and the formulation of a compelling business case and evolved into a larger global effort that involved technology vendors, supply chain partners, government regulators, and academic researchers.

Such complexity is a challenge in most other sectors. Lead producers in fields such as cars, clothing, and consumer electronics all rely on a global plant floor consisting of hundreds of suppliers to assemble and distribute finished products. For the managers overseeing the implementation of strategic projects in this context, project management increasingly means mobilizing knowledge, resources, and capabilities in partnership with a more diverse and globally dispersed network of participants.

The second insight concerns the increasingly vital role of disruptive technologies in the PMO toolkit. Artificial intelligence, blockchain, and IoT, in particular, are giving rise to incredibly powerful information systems that will become indispensable tools for modern project management. While companies like Walmart are using these tools to boost supply chain transparency and efficiency, PMOs can leverage the same information systems to track assets, assess and reduce risk, analyze performance, and gather insights to design and lead new change management initiatives. In other words, PMOs must not only support initiatives grounded in these disruptive technologies, but also be prepared to apply these new capabilities to PMO functions themselves.

As Bill Mabry, director of the digital transformation PMO at Salesforce, put it: "There's no doubt that the Fourth Industrial Revolution is having a direct impact on the traditional PMO. Unless PMOs recognize the change, they will be left in the background wondering what happened."⁸⁹

Conclusion and recommendations

Risk management now requires well-defined strategies and tools adapted to rapid, product-driven, highly collaborative implementations.

Are PMOs adjusting quickly enough to take advantage of the opportunities that blockchain is creating? Evidence from the field is mixed. Nearly 50 percent of all PMO directors surveyed by the Project Management Institute said their PMOs are either the "sole driver of" or "very involved in" change management intended to leverage disruptive technologies on behalf of their organization. Strong change management is important, because these initiatives often involve more stakeholders, making it more difficult to obtain consensus on specific goals, particularly from senior managers with legacy perspectives. PMOs are also expanding and integrating their knowledge with traditional project management fundamentals. For example, risk management now requires well-defined strategies and tools adapted to rapid, product-driven, highly collaborative implementations.



Only 30 percent of the PMO directors surveyed said their PMO has undergone reconfiguration as a direct result of disruptive technologies.

On the other hand, only 30 percent of the PMO directors surveyed said their PMO has undergone reconfiguration as a direct result of disruptive technologies. These reorganizations most likely involved innovative tools, products, and services; new skills required within the PMO; and modifications to the scope and/or methodologies of conventional project management. For those PMOs that have made progress, PMO directors reported uncertainty about the reconfigurations, with only 18 percent characterizing them as “very successful.”

We believe that, over time, blockchain will have breakthrough applications throughout the project management process, and we encourage organizations to explore and capitalize on this potential. Here are our recommended next steps.



Win the engagement and support of executive management.

PMOs can do this by leading the way in the adoption, expansion, and implementation of disruptive technologies. To do so, it will no longer be sufficient simply to master the fundamentals of project management. PMOs will need employees who fuse the ability to stay on top of emerging technologies with a well-refined business acumen. That means recruiting and developing project managers who can sense and respond to change, internalize and champion their organization’s strategic objectives, and understand how the projects they manage are positioning their organization to be more competitive in today’s marketplace. PMOs should also anticipate and counteract internal resistance to change. IT and operations departments, for example, might fear a radical rethinking of business models and the potential for reorganizing the business itself and displacing jobs. PMOs will need to anticipate these and other objections, and exercise diplomacy.



Engage with the blockchain community to understand the technology.

The properties of blockchain technologies and platforms differ from those of traditional IT solutions. Understand what makes them tick by taking an active role in the blockchain community and joining the conversation. If you have not already, try the technology yourself by downloading a wallet and trading cryptocurrencies. Or find and join a blockchain consortium that is focused on transforming your sector. Cross-sector consortia like Hyperledger and Ethereum provide a starting point, but there are sector-specific consortia as well. Such firsthand experiences are a prerequisite for developing use cases, pilot projects, and business cases. Blockchain consortia also provide a venue for partnering with a growing ecosystem of blockchain software start-ups that are developing enterprise-grade project management solutions. PMOs could provide valuable testbeds for their applications, while PMOs could leverage their expertise and agility to develop customized solutions rapidly for their organizations.

Blockchain consortia provide a venue for partnering with a growing ecosystem of blockchain software start-ups that are developing enterprise-grade project management solutions.



Pilots limit the risk of making failed investments in technologies or solutions that don't demonstrate a clear return on investment.



Identify use cases for blockchain adoption. Domains where blockchain implementations will be highly impactful for project management include the following:

- » Large and complex projects where success depends on the ability to mobilize people and resources across organizational boundaries
- » Projects where digital records of importance—such as digital identities, contracts, and payments—must be audited and carefully protected
- » Projects in which smart contracts can automate processes and transactions when contractual conditions are met and validated (e.g., issuing a payment when a piece of work is completed)
- » Projects where the provenance and ownership of physical and digital assets need to be tracked across a supply chain, market, or ecosystem of business participants.



Develop prototypes and pilot projects. This approach reduces resistance to change by introducing new technologies in incremental steps. Pilots also limit the risk of making failed investments in technologies or solutions that don't demonstrate a clear return on investment. For example, Walmart launched a few blockchain pilot projects focused on discrete food items like mangos and pork, before rolling out a larger supply chain traceability initiative. Any PMO interested in experimentation will also need to do some preliminary analysis: audit the systems currently in use, consult their users, and think about the people/organizations who'd need to be involved in the identification of viable options, the selection of one to prototype, the design of the prototype, the design of a pilot, and participation in a testing phase.



Develop a solid business case for investment in blockchain. PMOs seeking to deploy blockchain for project management will need to come armed with a compelling business case. The use cases for clinical trials, construction, and food safety are premised on the ability of blockchain to deliver bottom-line impacts by solving significant pain points in the respective sectors. PMOs can build their business cases by identifying ways blockchain can increase project success. This could include using blockchain to make work processes faster and more effective, or to improve their organization's capacity to operate in a trusted environment where success depends upon having a fast, easy, and transparent way to locate and share large quantities of data with specific individuals and entities.



Leverage blockchain and artificial intelligence to automate routine PMO functions. A good place to start is with the automation of routine PMO functions that would



PMOs can build their business cases by identifying ways blockchain can increase project success.

otherwise involve hours of administrative desk work for project managers. Self-executing contracts, for example, can define the rules and penalties around agreements for project deliverables, keeping participants on task. Distributed ledgers can help project managers cut down on time-consuming status reporting by providing project participants with a shared, real-time view of all significant project activities. Intelligent agents can automate or streamline tasks that are rules-based and repetitive like scheduling meetings and other project governance and accounting functions.

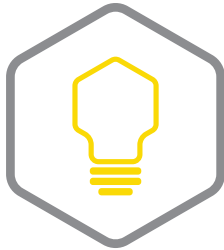


Lead change management efforts to complement blockchain adoption. PMOs surveyed by the Project Management Institute identified strong change management capabilities as increasingly important to project success. The case studies highlight the importance of change management as well. The adoption of blockchain-enabled project management in construction will require fundamental changes to how entities contract with each other and how they interact with and manage data. The pharmaceutical industry must accept that blockchain-enabled clinical trials will infuse greater transparency and integrity into its methods for testing new medical therapies and reporting the results. PMOs could work with the Project Management Institute to build change management capabilities that will complement their efforts to help foster the adoption of disruptive technologies.



Invest in next-generation PMO skills and capabilities. The use cases in clinical trials and construction demonstrate that blockchain is a powerful technology that can help PMOs focus their energies on leading and executing strategic initiatives in their organizations. In construction, streamlining the administrative overhead of contracts, work approvals, invoices, and payments with blockchain will free up project managers to spend less time on paperwork and reconciliation and more time on orchestrating resources and managing the disruptions and risks introduced by changing conditions and events outside the project proper. While the fundamentals of project management will remain important, blockchain enables PMOs to focus their talents on problem-solving, boosting productivity and helping their organizations achieve better project outcomes.





About the authors

Anthony D. Williams

Anthony Williams is co-founder and president of the DEEP Centre and an internationally recognized authority on the digital revolution, innovation, and creativity in business and society. He is co-author (with Don Tapscott) of the groundbreaking bestseller, *Wikinomics: How Mass Collaboration Changes Everything*, and its sequel, *Macrowikinomics: New Solutions for a Connected Planet*. Among other current appointments, Anthony is an expert advisor to the Markle Foundation's Initiative for America's Economic Future, a senior fellow with the Lisbon Council in Brussels and the Institute on Governance in Ottawa, and chief advisor to Brazil's Free Education Project, a national strategy to equip two million young Brazilians with the skills required for a 21st century workforce. His work on technology and innovation has been featured in such publications as the *Huffington Post*, *Harvard Business Review*, and *The Globe and Mail*.

Ricardo Viana Vargas

Ricardo Viana Vargas is a specialist in project management and strategy implementation. Over the past 20 years, he has been responsible for more than 80 major transformation projects in several countries, covering an investment portfolio of over \$20 billion. He is currently the executive director of the Brightline Initiative, a coalition of leading global organizations from business, government, and not-for-profit sectors. Ricardo is co-founder and managing partner of PMOtto.ai, a cutting-edge virtual assistant that uses chatbots, machine learning, and artificial intelligence to help users interact with project management software. From 2012 to 2016, Ricardo was the global director of the infrastructure and project management group with the United Nations Office for Project Services. Ricardo has written 15 books on project management and hosts the *Five Minutes Project Management* podcast, one of the most relevant podcasts in the field with more than four million plays and downloads.

Edivandro Carlos Conforto

Dr. Edivandro Conforto is a global research award winner and thought leader on organizational agility, strategy implementation, and agile transformation. His work and ideas help senior leaders transform their organizations to succeed in today's ever-changing business



environment. He is currently the head of strategy research at Brightline Initiative, responsible for the benefit pillar of thought and practice leadership through academic and professional research and publication of relevant content on strategic initiative management and capability building. From 2013 to 2015, he was a research associate at the Massachusetts Institute of Technology. Edivandro holds a PhD and a master's degree on organizational agility from USP-EESC, and has authored books and articles published internationally, including prestigious magazines and journals, such as *MIT Sloan Management Review*, *London School of Economics Business Review*, *Rotman Management Magazine*, *IJPM*, *PMJ*, and *JET-M*.

Tahirou Assane Oumarou

Tahirou Assane Oumarou has over 15 years of experience in leadership roles, civil engineering, and project management. As director of operations of the Brightline Initiative, Tahirou oversees the activities under the three benefit pillars of thought and practice leadership, networking, and capability building. From 2013 to 2017, Tahirou worked as the deputy director of infrastructure and project management group in the United Nations Office for Project Services supporting the successful implementation of peacebuilding, humanitarian, and development projects around the world. Prior to the United Nations, Tahirou was a senior project manager with the Ministry of Transportation in Ontario where he provided technical capabilities and expertise to ensure excellence in the delivery of complex highway projects with multidisciplinary teams.

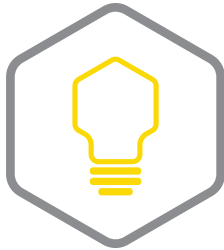
Disclosures

As of May 2019, none of the authors had investment or advisory relationships with any of the companies mentioned in this research. Several of the firms mentioned, such as Aon, IBM, and Sweetbridge, are members of the Blockchain Research Institute.

Acknowledgments

The Blockchain Research Institute and the authors would like to acknowledge and thank David Miryneck, blockchain consultant and director of research at MLG Blockchain, for assistance with the field research, as well as the following for participating in research interviews: Jerry Cuomo of IBM, Jack du Rose of Colony, Aidan Hyman of ChainSafe Systems, Scott Nelson of Sweetbridge, Bryan Peters of ConsenSys, and Irving Wladawsky-Berger of MIT. The authors extend special thanks to Robert "Bob" Morison for his considerable work on this project. Bob conducted research and prepared early drafts of this paper, and the authors are grateful for his contributions. Finally, the authors acknowledge Emil Andersson of the Brightline Initiative for his contributions to the work.





About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is a knowledge network organized to help realize the new promise of the digital economy. It builds on their yearlong investigation of distributed ledger technology, which culminated in the publication of their critically acclaimed book, *Blockchain Revolution* (Portfolio|Penguin).

Our syndicated research program, which is funded by major corporations and government agencies, aims to fill a large gap in the global understanding of blockchain technology and its strategic implications for business, government, and society.

Our global team of blockchain experts is dedicated to exploring, understanding, documenting, and informing leaders of the market opportunities and implementation challenges of this nascent technology.

Research areas include financial services, manufacturing, retail, energy and resources, technology, media, telecommunications, healthcare, and government as well as the management of organizations, the transformation of the corporation, and the regulation of innovation. We also explore blockchain's potential role in the Internet of Things, robotics and autonomous machines, artificial intelligence, and other emerging technologies.

Our findings are initially proprietary to our members and are ultimately released under a Creative Commons license to help achieve our mission. To find out more, please visit www.blockchainresearchinstitute.org.

Research management

Don Tapscott — Co-Founder and Executive Chairman
Kirsten Sandberg — Editor-in-Chief
Hilary Carter — Managing Director

Others in the BRI leadership team

Alisa Acosta — Director of Education
Luke Bradley — Director of Communications
Wayne Chen — Director of Business Development
Maryantonett Flumian — Director of Client Experience
Roya Hussaini — Director of Administration
Jody Stevens — Director of Finance
Alex Tapscott — Co-Founder





About the Brightline Initiative

Brightline is a Project Management Institute (PMI) initiative together with leading global organizations dedicated to helping executives bridge the expensive and unproductive gap between strategy design and delivery. Brightline delivers insights and solutions that empower leaders to successfully transform their organization's vision into reality through strategic initiative management. Learn more at www.brightline.org.

Notes

1. "Success in Disruptive Times: Expanding the Value Delivery Landscape to Address the High Cost of Low Performance," 10th Global Project Management Survey, Project Management Institute, 3 July 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2018.pdf; Dick Billows, "Why Projects Fail So Often," *4pm.com*, 27 Sept. 2015. 4pm.com/2015/09/27/project-failure, both accessed 11 Aug. 2018.
2. Kevin Sneader and Joe Ngai, "China's One Belt, One Road: Will It Reshape Global Trade?" July 2016, in *McKinsey Podcast*, hosted by Cecilia Ma Zecha, McKinsey & Company, MP3 audio. www.mckinsey.com/featured-insights/china/chinas-one-belt-one-road-will-it-reshape-global-trade, accessed 11 May 2018. Updated data from "World Health Statistics 2018: Annex B," World Health Organization, 30 May 2018. who.int/entity/gho/publications/world_health_statistics/2018/en/index.html; and "Projected Real Gross Domestic Product (GDP) and Growth Rates of GDP for Baseline Countries/Regions (in billions of 2010 dollars) 2010-2030," World Bank, updated 13 Dec. 2018. api.worldbank.org/v2/en/indicator/NY.GDP.PCAP.CD?downloadformat=excel, both accessed 5 May 2019.
3. Novid Parsi, "Biggest Program of All Time? China's Sprawling Belt and Road Infrastructure Initiative," *PM Network* 31, no. 9 (2017): 16–17. Project Management Institute, www.pmi.org/learning/library/china-belt-road-infrastructure-program-10902, accessed 11 Aug. 2018.
4. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium: Building Digital Trust for Cross-Border Trade," foreword by Don Tapscott, Blockchain Research Institute, 24 May 2018.
5. Pindar Wong, "Blockchain: The Way Forward," *Hong Kong Means Business*, Hong Kong Trade Development Council, 14 June 2018. hkmb.hktdc.com/en/1x0ae8fx/first-person/blockchain-the-way-forward, accessed 11 Dec. 2018.
6. "Dedicate and Mobilize the Right Resources," *10 Guiding Principles*, Brightline Initiative, n.d. www.brightline.org/principles, accessed 26 March 2019.
7. For more technical detail on items such as consensus mechanisms and cryptographic hashing, see "Blockchain: A Technical Primer," *Deloitte Insights*, Deloitte Touche Tohmatsu Ltd., 6 Feb. 2018. www2.deloitte.com/insights/us/en/topics/emerging-technologies/blockchain-technical-primer.html, accessed 23 April 2019. For more examples, see Bernard Marr, "35 Amazing Real World Examples of How Blockchain Is Changing Our World," *Forbes*, Forbes Media LLC, 22 Jan. 2018. www.forbes.com/sites/bernardmarr/2018/01/22/35-amazing-real-world-examples-of-how-blockchain-is-changing-our-world/#4530101743b5, accessed 23 April 2019.
8. Techworld Staff, "The Most Infamous Data Breaches," *Techworld*, International Data Group, 16 April 2019. www.techworld.com/security/uks-most-infamous-data-breaches-3604586, accessed 1 Oct. 2018.



9. Kate Rooney, "Plunge in Crypto Sets Stage for Facebook and Other Tech Giants to Hire Blockchain Experts," *CNBC*, NBCUniversal, last updated 12 Feb. 2019. www.cnbc.com/2019/02/11/plunge-in-crypto-sets-stage-for-facebook-and-other-tech-giants-to-hire-blockchain-experts.html, accessed 4 March 2019.
10. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 6th ed. (Newtown Square, PA: Project Management Institute, 2017): 48.
11. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 6th ed. (Newtown Square, PA: Project Management Institute, 2017): 48.
12. "Success in Disruptive Times: Expanding the Value Delivery Landscape to Address the High Cost of Low Performance," 10th Global Project Management Survey, Project Management Institute, 3 July 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2018.pdf, accessed 23 April 2019.
13. Carolyn Eichler and Attiya Salik, "The Next Generation PMO," PMI's Thought Leadership Series, Project Management Institute, 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/disruptive-technologies/next-generation-pmo.pdf?sc_lang_temp=en, accessed 2 Dec. 2018.
14. Sara Robinson, "How Corporations Have Made America like the USSR," *Salon.com*, Salon Media Group, 17 July 2012. www.salon.com/2012/07/17/the_new_totalitarianism_how_american_corporations_have_made_america_like_the_soviet_union_salpart, accessed 3 Dec. 2018.
15. "Testing Organizational Boundaries to Improve Strategy Execution," Research Report, *Harvard Business Review* Analytic Services, Brightline Initiative, 8 April 2019. s3.us-east-2.amazonaws.com/brightline-website/downloads/reports/HBR_Research-Report_Brightline.pdf, accessed 10 April 2019.
16. Ann Mettler and Anthony D. Williams, "The Rise of the Micro-Multinational: How Freelancers and Technology-Savvy Start-Ups Are Driving Growth, Jobs and Innovation," Policy Brief, The Lisbon Council, 2011. www.lisboncouncil.net/publication/publication/81-the-rise-of-the-micro-multinational-how-freelancers-and-technology-savvy-start-ups-are-driving-growth-jobs-and-innovation.html, accessed 23 April 2019.
17. Google, "The Decisive Decade: How the Acceleration of Ideas Will Transform the Workplace by 2020," Nov. 2010, pp. 1-27. lp.google-mkto.com/rs/google/images/Google-Decisive-Decade-Report-Future-Foundation.pdf, accessed 23 April 2019.
18. John Steen, Robert DeFillippi, Jörg Sydow, Stephen Pryke, and Ingo Michelfelder, "Projects and Networks: Understanding Resource Flows and Governance of Temporary Organizations with Quantitative and Qualitative Research Methods," *Project Management Journal* 49, no. 2 (2018): 3-17. Project Management Institute, www.pmi.org/learning/library/projects-networks-11119, accessed 4 Oct. 2018.
19. Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Portfolio/Penguin, 2016): 90.
20. Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Portfolio/Penguin, 2016): 90.
21. Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Portfolio/Penguin, 2016): 90.
22. Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Portfolio/Penguin, 2016): 90.
23. Bryan Peters, interviewed via telephone by Robert Morison, 27 April 2018.
24. Narrative Science, n.d. www.narrativescience.com, accessed 23 April 2019.
25. William D. Eggers, David Schatsky, and Dr. Peter Viechnicki, "AI-Augmented Government: Using Cognitive Technologies to Redesign Public Sector Work," *Deloitte Insights*, Deloitte University Press, 26 April 2017. dupress.deloitte.com/dup-us-en/focus/cognitive-technologies/artificial-intelligence-government.html, accessed 4 March 2019.
26. Carolyn Eichler and Attiya Salik, "The Next Generation PMO," PMI's Thought Leadership Series, Project Management Institute, 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/disruptive-technologies/next-generation-pmo.pdf?sc_lang_temp=en, accessed 2 Dec. 2018.
27. "Harnessing the Power of Feedback Loops for Strategy Design and Delivery," Infographic by *The Economist*, Brightline Initiative, 2017. www.brightline.org/resources/brightline-infographic-harnessing-the-power-of-feedback-loops, accessed 27 March 2019. EIU surveyed 500 senior executives from different organizations around the globe.



28. Carolyn Eichler and Attiya Salik, "The Next Generation PMO," PMI's Thought Leadership Series, Project Management Institute, 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/disruptive-technologies/next-generation-pmo.pdf?sc_lang_temp=en, accessed 2 Dec. 2018.
29. "Designing a Marketing Organization for the Digital Age," *Harvard Business Review*, 1 Oct. 2015. hbr.org/sponsored/2015/10/designing-a-marketing-organization-for-the-digital-age, accessed 26 Nov. 2018.
30. "Designing a Marketing Organization for the Digital Age," *Harvard Business Review*, 1 Oct. 2015. hbr.org/sponsored/2015/10/designing-a-marketing-organization-for-the-digital-age, accessed 26 Nov. 2018.
31. "Success in Disruptive Times: Expanding the Value Delivery Landscape to Address the High Cost of Low Performance," 10th Global Project Management Survey, Project Management Institute, 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2018.pdf, accessed 23 April 2019.
32. Marco Iansiti and Karim R. Lakhani, "The Truth about Blockchain," *Harvard Business Review*, Jan.–Feb. 2017. hbr.org/2017/01/the-truth-about-blockchain, accessed 7 Nov. 2018.
33. Marco Iansiti and Karim R. Lakhani, "The Truth about Blockchain," *Harvard Business Review*, Jan.–Feb. 2017. hbr.org/2017/01/the-truth-about-blockchain, accessed 7 Nov. 2018.
34. John P. A. Ioannidis, "Why Most Published Research Findings Are False," *PLoS Medicine* 2, no. 8 (30 Aug. 2005): 124. PLoS, journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.0020124, accessed 23 April 2019.
35. Ken Getz, "Anticipating Patient Engagement's Impact on the Evolution of Clinical Research," Presentation, CTO 2018 Conference, Center for the Study of Drug Development, Tufts University School of Medicine, Boston, MA, 28 March 2018. www.ctontario.ca/cms/wp-content/uploads/2018/06/KGetz-CTO-2018.pdf, accessed 4 March 2019.
36. Net Savings Link, "Nsav to Develop and Deploy Blockchain for Its Clinical Research Business," *GlobeNewswire*, GlobeNewswire, Inc., 9 Feb. 2018. www.globenewswire.com/news-release/2018/02/09/1338541/0/en/Nsav-to-Develop-and-Deploy-Blockchain-for-Its-Clinical-Research-Business.html, accessed 15 April 2019.
37. Aaron Stanley, "Big Pharma Seeks DLT Solution for Drug Costs," *CoinDesk*, Digital Currency Group, 9 Jan. 2018. www.coindesk.com/blockchain-day-big-pharma-seeks-dlt-solution-drug-costs, accessed 4 March 2019.
38. Mehdi Benchoufi and Philippe Ravaud, "Blockchain Technology for Improving Clinical Research Quality," *PubMed.gov* 18, no. 1 (19 Jul. 2017): 335. National Center for Biotechnology Information, www.ncbi.nlm.nih.gov/pubmed/28724395, accessed 23 April 2019.
39. Mehdi Benchoufi and Philippe Ravaud, "Blockchain Technology for Improving Clinical Research Quality," *PubMed.gov* 18, no. 1 (19 Jul. 2017): 335. National Center for Biotechnology Information, www.ncbi.nlm.nih.gov/pubmed/28724395, accessed 23 April 2019.
40. Aaron Stanley, "Big Pharma Seeks DLT Solution for Drug Costs," *CoinDesk*, Digital Currency Group, 9 Jan. 2018. www.coindesk.com/blockchain-day-big-pharma-seeks-dlt-solution-drug-costs, accessed 4 March 2019.
41. Mike Novotny, "Blockchain in Clinical Trials: A New Era for Our Data," *Clinical Research News*, Cambridge Innovation Institute, 19 Sept. 2018. www.clinicalinformaticsnews.com/2018/09/19/blockchain-in-clinical-trials-a-new-era-for-our-data.aspx, accessed 4 March 2019.
42. Robert L. Comis et al., "Public Attitudes Toward Participation in Cancer Clinical Trials," *Journal of Clinical Oncology* 21, no. 5 (1 March 2003): 830–835. National Center for Biotechnology Information, www.ncbi.nlm.nih.gov/pubmed/12610181, accessed 23 April 2019.
43. "Interview with Ken Getz: Exploring Challenges of Clinical Trial Operations, Part 1," *Cytel.com*, Cytel, Inc., 5 April 2018. www.cytel.com/blog/interview-kengetz-challenges-clinical-trial-operations, accessed 4 March 2019.
44. Aaron Stanley, "Big Pharma Seeks DLT Solution for Drug Costs," *CoinDesk*, Digital Currency Group, 9 Jan. 2018. www.coindesk.com/blockchain-day-big-pharma-seeks-dlt-solution-drug-costs, accessed 4 March 2019.
45. Aaron Stanley, "Big Pharma Seeks DLT Solution for Drug Costs," *CoinDesk*, Digital Currency Group, 9 Jan. 2018. www.coindesk.com/blockchain-day-big-pharma-seeks-dlt-solution-drug-costs, accessed 4 March 2019.



46. Aaron Stanley, "Big Pharma Seeks DLT Solution for Drug Costs," *CoinDesk*, Digital Currency Group, 9 Jan. 2018. www.coindesk.com/blockchain-day-big-pharma-seeks-dlt-solution-drug-costs, accessed 4 March 2019.
47. Jerry Cuomo, interviewed via telephone by Robert Morison, 3 April 2018.
48. Aled Edwards, interviewed via telephone by Anthony Williams, 13 Feb. 2019.
49. Jerry Cuomo, interviewed via telephone by Robert Morison, 3 April 2018.
50. Roland Haslehner, Frédéric Jobert, Jacopo Brunelli, Andrea Nogara, Roberto Rodio, and Davide Véroux, "Boosting Productivity in Construction with Digital and Lean," *www.bcg.com*, Boston Consulting Group, 10 Oct. 2018. www.bcg.com/publications/2018/boosting-productivity-construction-digital-lean.aspx, accessed 14 Feb. 2019.
51. World Economic Forum and Boston Consulting Group, "Future Scenarios and Implications for the Industry: Shaping the Future of Construction," foreword by Sandra Wu WenHsiu and Luis Castilla, with preface by Olivier Schwab and Michael Max Buehler, *WEForum.org*, March 2018. www3.weforum.org/docs/Future_Scenarios_Implications_Industry_report_2018.pdf, accessed 14 Feb. 2019.
52. Rajat Agarwal, Shankar Chandrasekaran, and Mukund Sridhar, "Imagining Construction's Digital Future," *Capital Projects and Infrastructure*, McKinsey Productivity Sciences Center, Singapore, June 2016. www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future, accessed 19 Nov. 2018.
53. Adam Higgins, "Seven Major Construction Technology Trends to Watch in 2019," *Connect & Construct*, Autodesk BIM 360, 15 Feb. 2019. connect.bim360.autodesk.com/construction-technology-innovation-2019, accessed 4 March 2019.
54. James Cook, "Eight Innovations in Construction Technology Poised to Disrupt the Industry," *PlanGrid Construction Productivity Blog*, PlanGrid, Inc., 26 Sept. 2017. blog.plangrid.com/2017/09/8-innovations-construction-technology-poised-disrupt-industry, accessed 4 March 2019.
55. David Bowcott, interviewed via telephone by Anthony Williams, 7 March 2019.
56. Marc Minnee, interviewed via telephone by Anthony Williams, 27 Feb. 2019.
57. Marc Minnee, interviewed via telephone by Anthony Williams, 27 Feb. 2019.
58. Marc Minnee, "Project Management Blockchain," *Medium*, A Medium Corporation, 18 Dec. 2016. medium.com/@marc.minnee/project-management-blockchain-8f14abea49f8; Marc Minnee, "Project Management Blockchain—Part 2," *Medium*, A Medium Corporation, 6 July 2017. medium.com/@marc.minnee/project-management-blockchain-part-2-df6b944aca26; and Marc Minnee, "On Participating in Blockchains," *Medium*, A Medium Corporation, 28 March 2017. medium.com/@marc.minnee/on-participating-in-blockchains-ce6d11712a7, all accessed 19 Nov. 2018.
59. Marc Minnee, interviewed via telephone by Anthony Williams, 27 Feb. 2019.
60. Marc Minnee, interviewed via telephone by Anthony Williams, 27 Feb. 2019.
61. Aon Risk Solutions, "Technology Corner Profile," Aon Reed Stenhouse Inc., 2018. www.aon.com/getmedia/dbc61848-f07a-4838-bfb0-a28a1bec86b9/Brickchain-Tech-Profile-V1-0-9-7-18.aspx, accessed 19 Nov. 2018.
62. Tom Sawyer, "In a First, the Project Deliverables Include a Blockchain Twin," *Engineering News-Record*, 6 Aug. 2018. www.enr.com/articles/44948-in-a-first-the-project-deliverables-include-a-blockchain-twin?v=preview, accessed 19 Nov. 2018.
63. Ellis Talton, interviewed via telephone by Anthony Williams, 22 Feb. 2019.
64. "Brickschain Partners with Probuild Constructions Australia to Bring Construction Blockchain across Its Supply Chain from China," *GlobeNewswire*, GlobeNewswire, Inc., 25 Sept. 2018. globenewswire.com/news-release/2018/09/25/1575945/0/en/Brickschain-Partners-with-Probuild-Constructions-Australia-to-bring-Construction-Blockchain-across-its-supply-chain-from-China.html, accessed 19 Nov. 2018.
65. Construction Blockchain Consortium, University College London, n.d. www.constructionblockchain.org, accessed 19 Nov. 2018.
66. Stephen White, "Dubai Blockchain Strategy in Focus at Cityscape Global," *ME Construction News*, CPI Trade Media, 25 Sept. 2018. meconstructionnews.com/31466/dubai-blockchain-strategy-in-focus-at-cityscape-global, accessed 19 Nov. 2018.
67. Ellis Talton, interviewed via telephone by Anthony Williams, 22 Feb. 2019.
68. Rajat Agarwal, Shankar Chandrasekaran, and Mukund Sridhar, "Imagining Construction's Digital Future," *Capital Projects and Infrastructure*, McKinsey Productivity Sciences Center, Singapore, June 2016. www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future, accessed 19 Nov. 2018.
69. David Bowcott, interviewed via telephone by Anthony Williams, 7 March 2019.



70. Scott Nelson, interviewed via telephone by Robert Morison, 20 April 2018.
71. "Food Safety," World Health Organization, 31 Oct. 2017. www.who.int/news-room/fact-sheets/detail/food-safety, accessed 9 Nov 2018.
72. See, for example, the recent incident with E. coli contaminated romaine lettuce in North America. Sandee LaMotte, "Deadly E. coli Outbreak in Lettuce Traced to Contaminated Water," CNN, Turner Broadcasting System, Inc., last updated 29 June 2018. www.cnn.com/2018/06/29/health/e-coli-romaine-lettuce-outbreak-cause/index.html; "Public Health Notice—Outbreak of E. coli Infections Linked to Romaine Lettuce," Government of Canada, last updated 22 June 2018. www.canada.ca/en/public-health/services/public-health-notices/2018/public-health-notice-outbreak-e-coli-infections-linked-romaine-lettuce.html, both accessed 23 April 2019.
73. "FDA Food Safety Modernization Act (FSMA)," US Food and Drug Administration, US Department of Health and Human Services, last updated 15 Nov. 2018. www.fda.gov/food/guidanceregulation/fsma, accessed 4 March 2019.
74. Bruce Welt and J. Ralph Blanchfield, "Food Traceability," *IUFoST Scientific Information Bulletin*, International Union of Food Science and Technology, March 2012. www.iufost.org/iufostftp/IUF.SIB.Food%20Traceability.pdf, accessed 4 March 2019.
75. Ian Allison, "IBM Enlists Walmart, Nestlé, Unilever, Dole for Food Safety Blockchain," *International Business Times*, IBT Media, last updated 22 Aug. 2017. www.ibtimes.co.uk/ibm-enlists-walmart-nestle-unilever-dole-food-safety-blockchain-1636068, accessed 28 Aug. 2017.
76. Rachel Ralte, "IFA Accuses Pig Processors of Undermining Pigmeat Market," *The Pig Site*, 5m Publishing, 7 Aug. 2017. www.thepigsite.com/swinenews/43938/ifa-accuses-pig-processors-of-undermining-pigmeat-market; Rachel Ralte, "Pig Premise ID Registrations Top 13 Thousand & Growing," *The Pig Site*, 5m Publishing, 2 Aug. 2017. www.thepigsite.com/swinenews/43919/pig-premise-id-registrations-top-13-thousand-growing, both accessed 7 Aug. 2017.
77. Fred Gale, "China's Pork Imports Rise Along with Production Costs," Report, Economic Research Service, US Department of Agriculture, Jan. 2017. www.ers.usda.gov/webdocs/publications/81948/ldpm-271-01.pdf?v=42745, accessed 30 June 2017.
78. Frank Yiannas, interviewed via telephone by Reshma Kamath, 28 June 2017.
79. Frank Yiannas, interviewed via telephone by Reshma Kamath, 28 June 2017.
80. Frank Yiannas, interviewed via telephone by Reshma Kamath, 28 June 2017.
81. Brigid McDermott, interviewed via telephone by Reshma Kamath, 23 June 2017.
82. Michael del Castillo, "Walmart Blockchain Pilot Aims to Make China's Pork Market Safer," *CoinDesk*, Digital Currency Group, last updated 20 Oct. 2016. www.coindesk.com/walmart-blockchain-pilot-china-pork-market, accessed 7 Aug. 2017.
83. Ron Miller, "This Is How Blockchain Can Keep Your Food Safe," *WEForum.org*, World Economic Forum, 23 Jan. 2019. www.weforum.org/agenda/2019/01/walmart-is-betting-on-the-blockchain-to-improve-food-safety, accessed 15 Feb. 2019.
84. Laurie Burkitt, "Walmart to Triple Spending on Food Safety in China," *The Wall Street Journal*, Dow Jones & Company Inc., last updated 17 June 2014. www.wsj.com/articles/wal-mart-to-triple-spending-on-food-safety-in-china-1402991720, accessed 29 June 2017.
85. Laurie Burkitt, "Walmart to Triple Spending on Food Safety in China," *The Wall Street Journal*, Dow Jones & Company Inc., last updated 17 June 2014. www.wsj.com/articles/wal-mart-to-triple-spending-on-food-safety-in-china-1402991720, accessed 29 June 2017.
86. Laurie Burkitt, "Walmart to Triple Spending on Food Safety in China," *The Wall Street Journal*, Dow Jones & Company Inc., last updated 17 June 2014. www.wsj.com/articles/wal-mart-to-triple-spending-on-food-safety-in-china-1402991720, accessed 29 June 2017.
87. Kim S. Nash, "Walmart Readies Blockchain Pilot for Tracking US Produce, China Pork," *The Wall Street Journal*, Dow Jones & Company Inc., 16 Dec. 2016. blogs.wsj.com/cio/2016/12/16/wal-mart-readies-blockchain-pilot-for-tracking-u-s-produce-china-pork, accessed 15 Aug. 2017.
88. Ron Miller, "This Is How Blockchain Can Keep Your Food Safe," *WEForum.org*, World Economic Forum, 23 Jan. 2019. www.weforum.org/agenda/2019/01/walmart-is-betting-on-the-blockchain-to-improve-food-safety, accessed 15 Feb. 2019.
89. Carolyn Eichler and Attiya Salik, "The Next Generation PMO," PMI's Thought Leadership Series, Project Management Institute, 2018. www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/disruptive-technologies/next-generation-pmo.pdf?sc_lang_temp=en, accessed 2 Dec. 2018.







blockchainresearchinstitute.org