

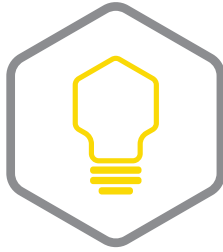
BLOCKCHAIN-DRIVEN TRANSFORMATION

How Distributed Ledger Technologies Have Changed the Enterprise Forever

Anthony Williams, Tahirou Assane, and Emil Andersson
DEEP Centre and the Brightline Initiative

August 2021





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, 2021

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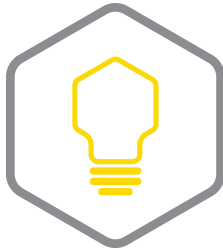
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Foreword

Blockchain Research Institute (BRI) members are aware of the transformative potential of distributed ledgers. No longer at proof-of-concept or pilot stage, blockchain applications are changing processes and practices for the better in business and society. This project checks on the status of transformational projects for registering assets (e.g., land registries and birth, death, and marriage records), tracking the flow of goods and commodities (e.g., conflict diamonds and commercial farming), automating contract administration (e.g., in commercial construction and financial instruments), and streamlining industry workflows (e.g., insurance reconciliation and clinical trials).

The project features a detailed case study on the UK based company Circular, which uses blockchain technology to help supply chain participants address environmental and human rights challenges surrounding cobalt production. Specifically, it addresses five issues: (1) vetting the supply chain participants, (2) reliably digitizing the commodity at source, (3) scanning and tracking the raw materials through the supply chain, (4) automating compliance to deter tampering at each production stage, and (5) adapting the solution to streamline industry workflows. Finally, the project anticipates the long-term impact of blockchain technology on global financial markets, identity management, and the Internet of Things. I am confident that BRI members will find this project innovative and instructive.

I have had a long and productive relationship with Anthony Williams, the lead author of this project, predating our bestselling books *Wikinomics: How Mass Collaboration Changes Everything* and *Macrowikinomics: Rebooting Business and the World*. Since then, we have collaborated on many projects at the intersection of technology, business, and society. Anthony has been a regular contributor to our research program and a collaborator with our members at the Project Management Institute: Tahirou Assane and Emil Andersson. This is their third research project together—a capstone study of blockchain transformation—and well worth the read for enterprise leaders who want to gauge their progress.



DON TAPSCOTT

*Co-Founder and Executive Chairman
Blockchain Research Institute*



With digital assets, smart contracts, and shared distributed ledgers, blockchain tech is a catalyst for enterprise transformation.

Idea in brief

- » While blockchain adoption is in the early stage, enough early adopters are sufficiently far ahead that we can point to numerous far-reaching enterprise and industry-level transformations in evidence today. Beyond the proof-of-concept or pilot stage, these blockchain applications are transforming how we do business.
- » Efficient asset markets—both real and intellectual property as well as financial and other digital assets—need registries that are secure, transparent, easy to access and use, and hard to dispute. Blockchain tech is well-suited to fulfill these functions.
- » Efficient asset chains—from sourcing of ingredients to enterprise procurement—need track-and-trace capabilities to verify authenticity, provenance, and regulatory compliance of all assets.
- » With shared distributed ledgers, supply chain parties can quickly verify status of assets and every agent in the process, including those who extracted, acted upon or altered, quality-tested and approved, transported and cleared at borders, financed, and insured them. Parties to complex projects such as building city infrastructure, can do the same during the construction process.
- » With smart contracts, partners in a supply chain or a largescale project can automate compliance with myriad international, national, and local codes, customs, standards, and regulations to streamline workflows.
- » With the trivergence of blockchain, artificial intelligence (AI), and the Internet of Things (IoT), we expect deep transformations of identity management systems, global payment rails, banking products and services, and global financial markets, with greater use of distributed software agents (aka bots), sensor technologies, and autonomous robots.

Introduction

Invention and reinvention—those are the two constants of the digital age. As disruptive technologies such as blockchain, AI, and IoT drive profound changes in the social and economic landscape, savvy enterprise leaders continually reinvent or transform how they conduct their core business. Transformation may mean bringing new products and services to market. It can also entail making significant structural changes to people, processes, and technologies to bring



Blockchain is one of the most disruptive forces of the past decade. Our prospects for harnessing it may be limited only by our imaginations.

new operational efficiencies. More than ever, winning enterprises distinguish themselves in the marketplace through their ongoing changes in corporate strategy and structure.

Ever since Satoshi Nakamoto mined the first bitcoins on the Bitcoin ledger, blockchain has earned its reputation as one of the most disruptive forces of the past decade. It is changing not only how we collect, record, and manage information but also how leaders across industries are harnessing it to drive sector-wide transformations, from accounting and healthcare delivery to resource extraction and construction.

When combined with machine learning, augmented reality, and other emerging technologies, the applications for blockchain across sectors can be profound. BRI and Brightline have been on the frontline, documenting blockchain's transformative power—from simplifying the complex clinical trials process for global pharmaceutical companies like Amgen, Pfizer, and Sanofi to tracing the provenance of food products for retail brands like Walmart and Golden State Foods.¹

The prospects for blockchain-enabled innovation may be limited only by our imaginations. However, hard-nosed executives seeking tangible transformations need practical blockchain applications that deliver clear returns on their investment today. Here we identify the material sector-wide transformations already underway and on the horizon.

Today's blockchain transformations

While blockchain adoption is in the early stage, enough early adopters are sufficiently far ahead that we can point to numerous far-reaching enterprise and industry-level transformations in evidence today. Beyond the proof-of-concept or pilot stage, these blockchain applications are transforming how we do business. Organizations are using blockchain registries for land titles, business incorporations, intellectual property rights, and other assets; blockchain-enabled systems for provenance and traceability in global supply chains; blockchain platforms for automating contract administration and enforcement; and distributed data management solutions for streamlining industry workflows that use blockchain as a coordinating mechanism (Table 1, next page).

Digital registries are a perfect use case for blockchain.

Registering assets

Digital registries are a perfect use case for blockchain. For land titles, business incorporations, patents, and other assets, such registries provide a secure infrastructure for swift and efficient transactions.

Governments seeking to administer efficient property markets need tamper-resistant registries that provide a complete history of land sale transactions. Buyers and sellers want to reduce transaction costs, including the risk of disputes. To do this, they need a title registry system that provides assurance that (1) the land in question



The blockchain-enabled land registry provides a complete and permanent transactional history for registered properties.

is the correct plot and (2) the seller is the rightful owner. Land registries must be straightforward for officials to administer and easy for buyers, sellers, and their legal representatives to access and search.

In one of several examples, blockchain start-up Blockscale Solutions built a blockchain-powered land registry in Haryana, India, in 2017. The Blockscale product can manage land titles with multiple owners and allow administrators to oversee the status of a given property and sale deed in near real time. Eventually, it will help to integrate records of rights with accurate and up-to-date cadastral maps.² The blockchain-enabled land registry provides a complete and permanent transactional history for registered properties, increases data security to protect the authenticity of land records, improves the end-user experience, and promotes citizen confidence in government.

More recently, the Inter-American Development Bank (IDB) commissioned Swedish blockchain pioneer ChromaWay to launch a pan-South American initiative to improve land administration in Bolivia, Peru, and Paraguay.³ Building on its Swedish blockchain land registry first piloted in 2016, ChromaWay's solution will harness the company's maturing suite of open-source blockchain technologies. Initiated in late 2019, the project is the first to design a blockchain-based land registry solution to meet the needs of three countries. ChromaWay and the IDB have also committed to helping Indigenous communities to secure title to land they collectively manage.

Table 1: Where blockchain is driving enterprise transformation

| Transformation opportunity | Use cases |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Recording assets | <ul style="list-style-type: none"> › Land registries › Business registries › Intellectual property registries › Birth, death, and marriage registries |
| Tracking the flow of goods and commodities | <ul style="list-style-type: none"> › Conflict diamonds › Cobalt and rare-earth minerals › Food products, pharmaceutical ingredients, and agricultural commodities › Manufacturing supply chains including three-dimensional printing facilities |
| Automating contract administration | <ul style="list-style-type: none"> › Commercial construction contracting › Issuance and management of new financial instruments |
| Coordinating and streamlining industry workflows | <ul style="list-style-type: none"> › Insurance reconciliations › Clinical trials |



Tracking assets through a supply chain

Provenance and traceability are vexing for companies and their supply chains. Brand conscious companies need complete visibility into the business practices of even the most distant suppliers, whether they're eliminating conflict stones from the global trade in rough diamonds or tracking the offshore manufacturing processes used to assemble iPhones and luxury apparel items.

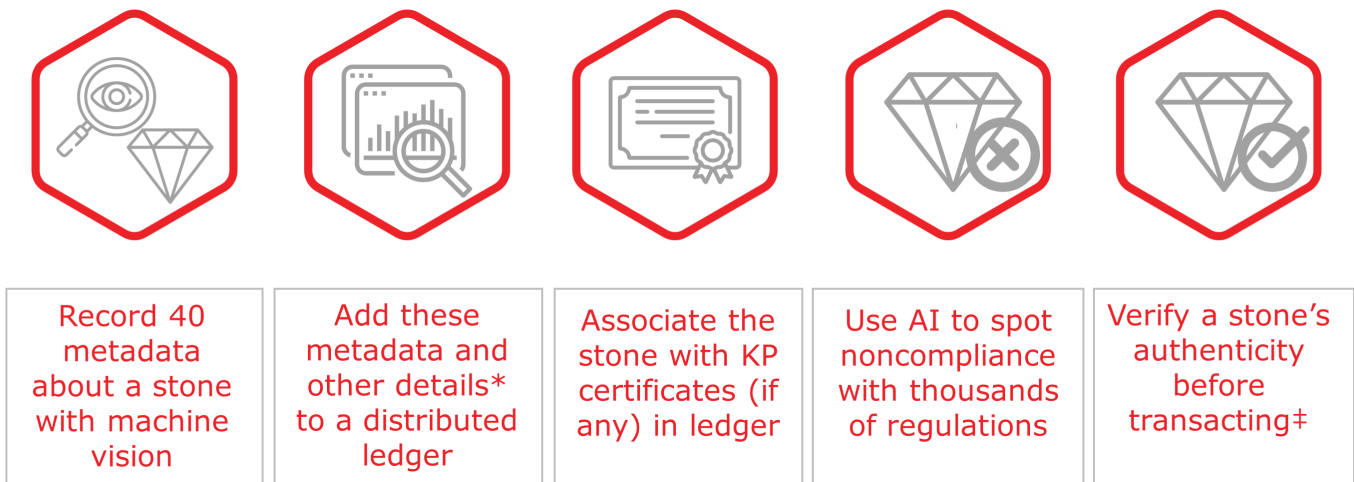
Companies can use immutable records to reassure consumers, regulators, and other stakeholders that they've ethically sourced their products.

Along with complementary IoT technologies like sensors and radio frequency identification (aka RFID), blockchain is addressing these concerns with new tools for tracking goods at each point in the chain and recording data chronologically on a distributed ledger. Companies can use these immutable records to reassure consumers, regulators, and other stakeholders that they've ethically sourced their products.

The London based company Everledger, for example, was the first to build a global digital ledger for diamonds that enables producers, consumers, insurers, and regulators to track the flow of individual diamonds, from the mines to the jeweler's display case. Everledger designed its blockchain solution to bring greater integrity to a largely paper-based diamond certification process plagued by corruption, forgeries, and inefficiencies, resulting in many so-called conflict diamonds entering the supply chain.

The Everledger process starts by creating a permanent record of a diamond's defining characteristics, history, and ownership on the

Figure 1: Tracking diamonds on the blockchain



*Details such as place of origin and chain of custody.

KP stands for Kimberley Process, a binding agreement to apply the KP Certification Scheme.

‡Transactions such as buying, issuing insurance, or paying insurance claim.

Source: Anthony D. Williams, "Diamonds on the Blockchain: Building a Global Digital ledger for Valuable Assets," foreword by Don Tapscott, Blockchain Research Institute, 22 Dec. 2017.



blockchain. This digital thumbprint is used by various stakeholders across a supply chain pipeline to track provenance and verify authenticity. Shifting the paper-based processes and documents to a tamper-resistant digitized version on the blockchain increases security and visibility for stakeholders and helps build trust along the supply chain.⁴ (See Figure 1, previous page.)

Everledger's clients include US based retailer Fred Meyer Jewelers, the Chow Tai Fook Jewelry Group in China, UK based jeweler Taylor & Hart, and Brilliant Earth, a specialist in ethically sourced bridal and fine jewelry. Collectively, Everledger has provided provenance for over two million diamonds since 2015.⁵

While conflict diamonds provided the first use case for Everledger's solution, the UK based company has since expanded its capabilities. A recent update to the platform in 2021 allows client companies to capture data on energy usage and greenhouse gas emissions produced during the extraction, processing, and transportation of a broad range of materials, from gemstones and critical minerals to manufactured goods like automobiles and electronics. Mining companies, manufacturers, retailers, and other stakeholders can even opt to offset their carbon footprint directly on Everledger's platform. New York City based supplier of polished diamonds, Shairu & Atit Diamonds, for example, not only tracks the origin of its diamonds using Everledger but also provides customers with real-time data on the carbon footprint of the diamond manufacturing process.⁶

Shifting the paper-based processes and documents to a tamper-resistant digitized version on the blockchain increases security and visibility for stakeholders and helps build trust along the supply chain.

Automating contract administration and enforcement

With blockchain, we can embed traditional legal agreements and contracts in digital code and store them in shared databases that protect them from tampering and deletion. Blockchain technologies are creating strategic opportunities to streamline and automate tasks involving hours of paperwork for lawyers and business managers. Self-executing contracts can enforce the rules and penalties around agreements. Distributed ledgers can also provide a real-time view of all deliverables and outcomes specified in a legal agreement. Participants need not spend time generating status reports.

Commercial construction, for example, often brings together large teams of contractors and subcontractors to design and shape the built environment. 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. Industry leaders are turning to blockchain to automate the contractual processes and paperwork, thereby saving money, freeing up valuable resources, and speeding up project delivery.

Edmonton and Denver based Intelliwave Technologies, for instance, provides construction management solutions to some of North America's largest and most complex building and infrastructure



SiteSense applications leverage secure blockchain technology combined with IoT devices, web, and mobile software to improve construction project visibility.

projects—from the New Orleans airport expansion project to Shell’s Pennsylvania chemicals project. The company’s flagship SiteSense applications leverage secure blockchain technology combined with IoT devices, web, and mobile software to improve construction project visibility.

The software captures and secures all the essential documentation for a construction project in a blockchain ledger that all parties can access in real time. The blockchain-encoded specifications for the construction assets are granular, from major commercial heating, ventilation, and air conditioning (aka HVAC) systems right down to paint colors, ceiling fixtures, LED bulbs, and door hardware. By scanning a simple QR code embedded on building materials, a site manager can access the serial numbers, photos and specifications, supply chain history, full quality documentation, and locations where the materials were stored.

When parties store and manage data on paper or in their own data siloes or spreadsheets, tracking down information is time consuming and costly. When SiteSense manages all the paperwork required to run a construction—requisitions, purchase orders, work orders, and building inspection forms—then parties can find what they need when they need it. A person’s role in the project determines the person’s visibility into transaction and asset data in the SiteSense ledger. It shares correct information automatically, securely, and quickly across multiple stakeholders, from architects and engineers to contractors, subcontractors, and building material suppliers.⁷

Other examples of blockchain automation in construction include Dubai Land Development, which implemented a smart contract infrastructure to automate contracting in Dubai’s real estate



Female civil engineer on site by *ThisisEngineering RAEng*, 2020, used under Unsplash license. Cropped to fit.



Structural issues and engrained habits in the construction sector mean that widespread blockchain adoption will take time.

development sector, and Briq, a California-based blockchain firm that uses blockchain to chronicle end-to-end building processes, thereby creating a powerful data repository for the entire lifespan of commercial buildings.⁸ These use cases notwithstanding, structural issues and engrained habits in the construction sector mean that widespread blockchain adoption will take time.

Nancy Greenwald, executive director of the Construction Institute, found that the major obstacles to adopting blockchain and smart contract technology effectively in construction are the complexity of the contracts and the lack of standardization in processes.⁹ Greenwald also argued that the industry's stubbornness in embracing new technologies and shifting to more collaborative relationships put it at risk of disruption—just as Uber disrupted the transportation industry and Airbnb, the hospitality industry.

Ellis Talton, chief of staff for Briq, has experienced these challenges firsthand. "The construction industry is technologically advanced in many aspects of what it does, but the industry is very relationship based," said Talton. Citing the prevalence of family-owned firms and private companies, Talton noted that 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. "Some of the conservatism when it comes to technology adoption is related to the very risky nature of large-scale projects," said Talton.¹⁰

While the structural and cultural obstacles are real, so too is the growing evidence of the significant value to be reaped by all participants in the construction. For example, Hesam Hamledari and Martin Fischer of Stanford University studied the impact of blockchain and smart contracts on construction supply chains.¹¹ Their findings were impressive:

"Some of the conservatism when it comes to technology adoption is related to the very risky nature of large-scale projects."

 ELLIS TALTON
Chief of Staff
Briq Inc.

1. Blockchain improved information completeness and information accuracy respectively by an average 216 percent and 261 percent compared with the digital state-of-practice solution. The improvements were significantly more pronounced for inquiries that had higher product, trade, and temporal granularity.
2. [The] blockchain-enabled solution was robust in the face of increased granularity, while the conventional solution experienced 50 percent and 66.7 percent decline respectively in completeness and accuracy of information.¹²

Evidence such as this, with the growing cohort of early adopters, might be enough to assure industry innovators that the long-awaited digital disruption of construction has finally begun.



Streamlining industry workflows

The B3i consortium exemplifies how blockchain is simplifying and streamlining transactions in the catastrophic excess-of-loss reinsurance market.

Blockchain is also fundamentally changing how organizations collect, manage, and share information across organizational boundaries. In sectors such as insurance and healthcare, organizations that rely on shared information flows are replacing independently managed databases with a single blockchain-based repository of data. This single version of the truth, in turn, can eliminate errors, reduce paperwork, and simplify and speed up complex processes.

In the reinsurance marketplace, for example, the primary insurer routinely cedes some of its risk exposure to reinsurers, including catastrophic risks such as hurricanes or extreme weather events, which are covered in agreements between insurers and reinsurers. Brokers manage the primarily paper-based process, with all transacting parties reconciling amounts owed on their own ledgers. By the time they calculate exchange rates across multiple currencies and free up funds in the right amount, nearly two months could elapse before customers receive compensation for their loss.

The B3i consortium exemplifies how blockchain is simplifying and streamlining transactions in the catastrophic excess-of-loss reinsurance market. Using a blockchain-based system, the B3i consortium linked participating parties in the insurance ecosystem—including big names like Aegon, Allianz, Munich Re, Swiss RE, and the Zurich Insurance Group—into a shared data network. B3i designed the system to speed up communications, increase the visibility of the risk exposure of each party, and significantly reduce, if not remove, the need for reconciliations altogether, because all parties could share the same data.

"Blockchain technology will have an immense and cascading effect that will impact not only the insurance industry but commerce globally."

B3i launched a proof of concept (POC) of the blockchain solution in October 2017; another 23 insurers joined the market testing. The observed benefits included decreased transaction costs of foreign exchanges, savings of working capital because of more efficient controls over premium collection and claims reimbursement, and fewer operational risks due to data gaps and human errors within the network of insurers, brokers, and reinsurers. Ken Marke, former chief marketing and communications officer for B3i, was effusive in his assessment of the pilot:

 **KEN MARKE**
Former Chief Marketing and
Communications Officer
B3i Services AG

Businesses can operate in the face of big risks because they can insure against their risk exposure. Moreover, they can feel confident that, should disaster strike, insurers will honor their policies promptly. Blockchain technology will have an immense and cascading effect that will impact not only the insurance industry but commerce globally.¹³

The consortium declared the POC a success, and its members were eager to build a commercial product. Members decided incorporate. In March 2018, B3i Services AG officially debuted as an independent company. After another fundraising round, 18 insurance market participants became shareholders. According to B3i, over 40 companies are taking part in its ecosystem as shareholders,



customers, and community members.¹⁴ With its platform now in the market, B3i Services claims it can improve efficiency levels for its customers by up to 30 percent by improving speed, transparency, quality, security, and cost. Gerhard Lohmann, chief financial officer of Swiss RE, heralded the transition of B3i from consortium to independent company as a “concrete step forward to realizing the enormous potential of blockchain for the insurance industry.”¹⁵

Circular’s ethical sourcing solution

Digital registries, traceability solutions, and contract automation are powerful transformation tools. The most sophisticated blockchain use cases, however, weave these discrete tools into distributed data management solutions for complex industry-wide challenges. Consider the automotive and electronics sector, where UK based company Circular has developed a suite of blockchain-enabled tools for supply chain participants to address the environmental and human rights challenges surrounding cobalt production, a component in the lithium-ion batteries that power electric vehicles (EV).

The most sophisticated blockchain use cases weave digital registries, traceability solutions, and contract automation into distributed data management solutions for complex industry-wide challenges.

With EVs set to sweep the global automotive market, demand for lithium-ion batteries will likely increase. Lithium-ion battery manufacturing depends on access to raw materials, especially the minerals in the battery cathodes—nickel, lithium, copper, and cobalt. While several rare minerals are plagued by ethical sourcing concerns, cobalt presents the biggest concern for EV makers. These concerns include tight supply, volatile prices, and ethical supply chain issues associated with a long history of human rights violations in the Democratic Republic of the Congo (DRC), which accounts for roughly 65 percent of global cobalt extraction.

At its core, the Circular system is a traceability solution. Lithium suppliers like Vulcan Energy and brand name original equipment manufacturers (OEM) such as BMW, Polestar, and Volvo are using it to follow raw materials through the EV battery production process, creating an immutable audit trail that provides all parties with a nearly real-time view of the supply chain. However, the solution goes beyond basic traceability. Circular has invented a series of tools and processes to resolve the complex challenges in tracing cobalt production—processes to digitize the raw cobalt at the point of extraction, track its journey through supply chain, automate the compliance and contractual paperwork in each handoff, and streamline industry workflows (Figure 2, next page). In this sense, the Circular solution embodies the four blockchain-enabled transformations described in the previous section.

While blockchain technology is part of the solution for each step, blockchain alone is insufficient. As Circular’s founder Douglas Johnson-Poensgen explained:

A blockchain will record an immutable record of custody of a material, the locations it’s traveled through, its composition over time, and all that; but if you’re trying to make sure the wrong material never enters the system in the first place, you need processes to make this work.¹⁶



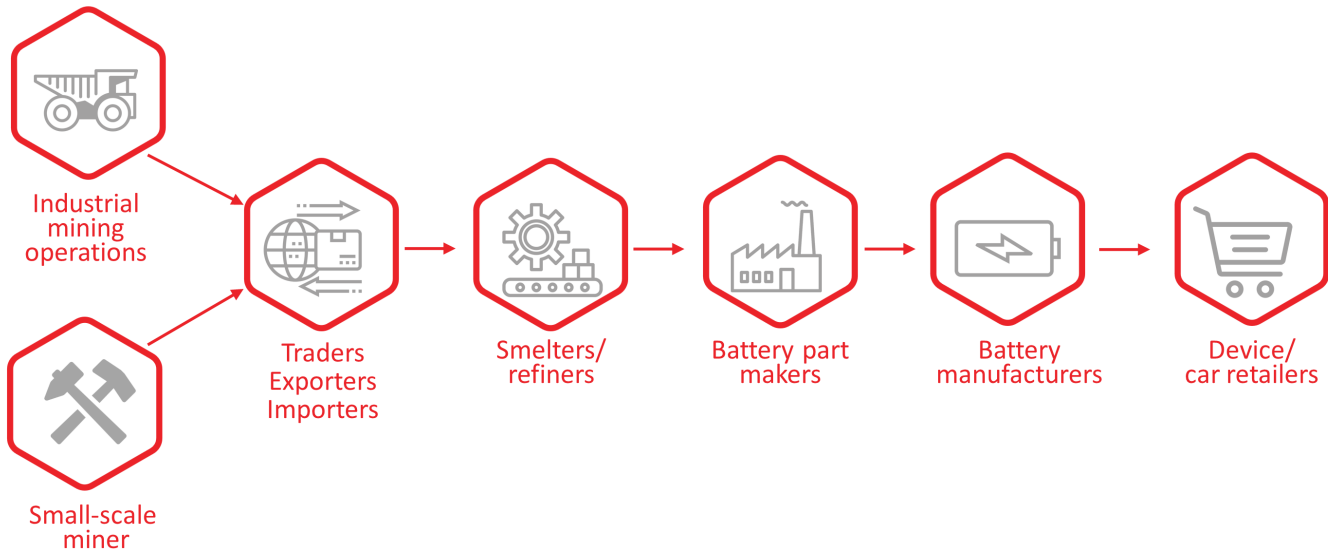
Accordingly, Circular’s approach to supply chain traceability combines technology with rigorous protocols, third-party audits, and on-the-ground due diligence. Circular built the blockchain component of its solution with Hyperledger Fabric and hosted on the Oracle Blockchain Platform. According to Johnson-Poensgen, Circular chose Fabric for several reasons:

Circular built the blockchain component of its solution with Hyperledger Fabric and hosted on the Oracle Blockchain Platform.

Hyperledger Fabric is as close to an enterprise standard as exists in blockchain, was designed for confidential transactions and didn’t need crypto to function. Corda was developed for use in financial services and is still not as cross-industry capable as Fabric. Although our first prototypes were built on Ethereum, we felt that a ledger requiring crypto to pay for the consensus mechanism, privacy concerns, network delays for committing transactions, and a proof of work consensus mechanism that was energy hungry made Ethereum inappropriate for commercial use at scale.¹⁷

The processes that complement this technology platform are equally important to sourcing cobalt from legitimate and well-managed mining concessions through Circular’s platform. Tracking a raw material through a supply chain boils down to solving five core problems: (1) vetting the supply chain participants, (2) reliably digitizing the commodity at its source, (3) scanning and tracking the raw materials through the supply chain, (4) automating compliance to deter tampering at each production stage, and (5) adapting the solution to streamline industry workflows.

Figure 2: Cobalt supply chain



Source of data: "This Is What We Die For": Human Rights Abuses in the Democratic Republic of the Congo Power the Global Trade in Cobalt," Amnesty International (AFR 62/3183/2016), 19 Jan. 2016.



1. Vetting the supply chain participants

To vet the mining sites, Circular partnered with Kumi Consulting to perform the litmus test on whether a mining location is operating responsibly and extracting cobalt ethically.

The cobalt supply chain is complex, with many stakeholders and production stages involved in transforming raw ore into end products. While extracted in places like the DRC, cobalt undergoes multiple processing steps in different countries before it is installed as batteries inside cars, mobile phones, and other electronics. Corruption, opacity, and poor regulation in the DRC have made it difficult for mining companies, processors, and manufacturers to verify that the minerals have not been tainted.

To verify the origin of minerals such as cobalt, any traceability protocol must include a robust chain of custody (CoC).¹⁸ According to RCS Global, a leader in data-driven responsible sourcing of natural resources, a CoC is defined as “all steps in a supply chain that takes possession of the product, including manufacturers, exporters, traders and importers.”¹⁹ Thus, Circular’s first challenge in establishing a clear CoC for OEM clients like BMW and Volvo is vetting each link of the supply chain—from miners to refiners, processors, and eventually manufacturers—to ensure that the materials have an ethical origin.²⁰

To address this challenge, Circular allows only accredited mining sites to access the platform. To receive accreditation, these sites must have perimeter fencing, security details, and measures preventing pregnant women and children from working in their mines. Most also have safety protocols limiting the depth of the pits miners can work in, with working conditions resembling European Union (EU) standards. To vet the mining sites, Circular partnered with Kumi Consulting—a specialist in responsible sourcing and the sole auditor for EU conflict minerals regulations—to perform the litmus test on whether a mining location is operating responsibly and extracting cobalt ethically.

2. Digitizing and registering the asset

Step two in establishing an ethical cobalt supply chain is digitizing the cobalt at its source.

Step two in establishing an ethical cobalt supply chain is digitizing the cobalt at its source. Digitization initiates the CoC in Circular’s system. It starts at the aggregation sites, which place vetted cobalt in secure bags, tag them with a QR code, and record them on Circular’s blockchain. Extra precautions, such as a facial recognition app to tighten security, are taken to ensure that the onsite person inputting data into the system is a trusted source.

“We focus on reliably capturing four things: who’s bringing the material; who’s recording the data to our system for the first time; where are they; and, finally, we assign an identity to a bagged quantity of raw cobalt in order to track it through the supply chain,” Johnson-Poensgen explained. The identity tags issued by Circular’s system indicate how, where, when, and by whom the materials will be used at various stages of the production process. “What that means is that there’s no black market for these materials, because ‘used anywhere else by anyone else’ immediately flags the material as an anomaly.”²¹



3. Tracing the asset through the supply chain

After digitizing and registering the asset, Circular provides the infrastructure for scanning and tracking the EV battery components at each location and stage of the process, from the mines and aggregation sites to the cobalt refineries and cathode manufacturing plants. While blockchain technology secures the ledger for recording data, Circular uses other technologies to complete the solution. For example, the start-up developed mobile scanning apps for midstream refiners, recyclers, and cathode manufacturers to track the flow of materials through their operations. “Many of the midstream supply chain participants in China don’t have scan-in scan-out technologies or sophisticated quality management systems,” said Johnson-Poensgen. “Almost everything still gets done on paper.”²²

4. Automating compliance

The fourth and trickiest step is to deter tampering and ensure compliance at subsequent refining and production stages in the supply chain. To do that, Circular developed a protocol called Dynamic Identity. The protocol uses several smart contracts to enforce tests on the data about a production or manufacturing process to judge whether the materials in the end product of that process can be reliably connected to the original input materials. One test in the Dynamic Identity process is “mass balance,” an application of conservation of mass principle that accounts for materials leaving and entering a process. Another test is a “proof of elapsed time.” If a manufacturing process takes 15 days, for example, then materials arriving on Monday can’t be the same vetted materials in the output product the following day.²³ Circular codes the tests as rules that, if passed, allow manufacturers to claim that they have ethically sourced their input materials.

Any changes to the ledger are done by users subject to data integrity checks and data validation checks.

Data governance—that is, who can access to Circular’s traceability solution, including who can add and view data on the ledger—is critical to maintaining the integrity of the results. Like many an enterprise blockchain application, Circular uses a private permissioned system. Johnson-Poensgen explained, “Users are able to see only the data they are permissioned to see, which generally includes their own data and the subset of data generated by their suppliers.”²⁴ Any changes to the ledger are done by users subject to data integrity checks and data validation checks, for which Circular uses AI or machine learning along with the validation rules described above.

5. Streamlining industry workflows

The final challenge is mapping the Circular solution to the unique supply chain dynamics and workflows of its customers so that it is scalable, cost effective, and efficient. Thousands of companies rely on cobalt as an integral part of their products, and so an ethical sourcing solution must span several industries particularly. EV makers are not alone in requiring large quantities of cobalt to



Circular believes it can achieve effective traceability by connecting critical nodes at each tier of the supply chain.

manufacture their products; makers of gas turbines, jet engines, and orthopedic implants also use the lustrous silver-grey metal in high-performance alloys.

Circular believes it can achieve effective traceability by connecting critical nodes at each tier of the supply chain. "Participants at every supplier tier from source to OEM need to participate to enable end-to-end traceability, but that doesn't mean you need large numbers at every tier to gain benefit," said Johnson-Poensgen. He added:

Currently we start at the OEM and map back to the upstream source. Then you track material flow through to the downstream participants. It could be as few as four participants [e.g., OEM, component manufacturer, refiner, mine]. Obviously, few supply chains are that linear or short, and most supply chains are networks. However, if you can map a path, you can provide traceability if the participants at each tier join in.²⁵



Black and silver car on parking lot by Micheal Fousert, 2021, used under Unsplash license. Cropped to fit.

Johnson-Poensgen tested the system with known sources of clean cobalt. "It makes economic sense to start with sources that aren't a problem," said Johnson-Poensgen. "Once the system is proven and operating at scale, one can tackle the harder use cases like artisanal miners."²⁶ So Circular adds only those companies and mining operations that have demonstrated that they are sourcing the mineral responsibly. In the case of BMW, Circular is helping the automaker trace known clean sources of cobalt coming from Australia, Canada, the United States, and certain well-regulated operations from within the DRC.²⁷

Volvo, on the other hand, initially used recycled cobalt in its electric car batteries to avoid sourcing raw cobalt from the DRC. Its first



Jan Carlson, a senior procurement leader at Volvo, explained how Circular instills confidence in the true origin of all the cobalt in their batteries.

blockchain project with Circular tracked cobalt from a Chinese recycling plant to Volvo's manufacturing plant in Zhejiang, China, over two months in 2019.²⁸ As Volvo ramped up to electrify its vehicle lineup in 2020, it expanded its work with Circular to accommodate the automaker's need for lithium-ion batteries with raw cobalt from the DRC. Jan Carlson, a senior procurement leader at Volvo, explained how Circular instills confidence in the true origin of all the cobalt in their batteries. Carlson said:

One single audit per year is not enough. Instead, we need to be on the ground regularly and make sure that we properly trace, label, and tag all minerals from the region. By doing that at the source and putting this data in a blockchain, a digital ledger that cannot be tampered with and is accessible to everyone involved, we can make great strides into creating a transparent and ethical supply chain. But in countries like the DRC, that is not an easy task, and it requires vigilance from all involved.²⁹

The vigilance and due diligence required to validate CoC is time consuming. The lack of standardized CoC platforms, the primitive level of digitization among upstream supply chain participants, and the need for training on how to deploy supply chain traceability solutions all compound the efforts.

Streamlining these processes through blockchain-enabled automation makes Circular a valuable partner to companies like BMW and Volvo. "The combination of physical audit, plus the integrity of the blockchain-enabled process is what gives us that reliable chain of custody," said Johnson-Poensgen. "To create absolute certainty for companies like Volvo requires a segregated process all the way through the supply chain, which is enforced by our blockchain solution."³⁰

Circular's work with BMW, Volvo, Polestar, and others in the EV market has cemented the company's credibility.

While Circular is automating as much of its solution as possible, Johnson-Poensgen conceded that he has had to deploy quite a few people to China to help establish rigorous business processes and provide adequate onboarding and training services for supply chain participants. "Once I've learned to automate as much of this as possible," he said, "I hope to partner with the big consultancies to help clients like car manufacturers and battery manufacturers implement these solutions into their supply chains."³¹

Circular's work with BMW, Volvo, Polestar, and others in the EV market has cemented the company's credibility. The next step, according to Johnson-Poensgen, is to expand the client base to aerospace, consumer electronics, and other mining sectors. The provenance of the cobalt in EV batteries is only one of components with ethical sourcing implications in manufacturing cars and electronics. In fact, the European Commission identified 18 materials around which it would like to see industry implement responsible sourcing practices.³² Beyond cobalt and the EV market, sustainability issues surround most natural resources. "Deforestation, industrial farming, flooding, chemical contamination, and dislocation of



communities are just some of the issues that both manufacturers and consumers need to be aware of,” said Johnson-Poensgen.³³

Blockchain transformations on the horizon

Circular and its partners in the automotive EV market have devised and implemented a full end-to-end solution for enabling ethical sourcing of cobalt for lithium-ion battery production. Others such as the B3i consortium, Intelliwave, Everledger, and Blockscale have identified niches where blockchain innovation is on the verge of driving industry-wide transformation. What should enterprise leaders anticipate next? BRI has been tracking several applications with POCs and working models in financial services, identity management, and IoT integration.

What should enterprise leaders anticipate next? Disruption in financial services, identity management, and IoT integration.

Blockchain-based banking and global financial markets

From mobile payments and cryptocurrencies to robo-advisors and algorithmic trading systems, few areas of the global financial system remain untouched by digital innovation. Yet, apart from the emergence of cryptocurrencies, the world of banking and finance has not fully realized the transformative potential of blockchain. The major institutions have experimented with distributed ledger technologies (DLT), but none have reinvented themselves around blockchain infrastructures—most likely because blockchain-based innovation could fundamentally disrupt the long-standing and highly lucrative business models underpinning banking and financial markets.³⁴

In banking, blockchain could disintermediate many of the key services that banks provide, from storing value, enabling payments, and settling trades. Payments are especially profitable for incumbent banks and other upstarts like Square and PayPal. According to McKinsey, global payments revenues in 2020 were nearly \$2 trillion and accounted for 40 percent of banking-sector revenues.³⁵ With blockchain technology, payments can be sent quickly, securely, and cheaply without the need for third-party verifications.

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The opportunity (or risk) of blockchain-enabled disruption is similar for financial markets. Primary capital market processes for issuing new debt and equity deals remain locked in a largely analog world where legacy infrastructure and inefficient practices add days and significant cost to new issues. While a great deal of the banking world has shifted online, veteran operators in the primary capital markets still execute deals today in much the same way they did 20 years ago.

In 2017, a UK based fintech start-up Nivaura made history by issuing the world’s first legally compliant cryptocurrency denominated bond. LuxDeco, an online retailer of luxury furniture and home decor accessories, issued two blockchain-enabled bonds using Nivaura’s platform: a control bond and an experimental bond. The control bond was a traditional sterling bond structured conventionally. The



experimental bond was an ether-denominated bond structured, executed, and administered through the Nivaura platform and cleared and settled on the Ethereum public blockchain (Figure 3). While the transactions were true financings for the issuer, they were also experiments to see what Nivaura could do for its clients using blockchain.

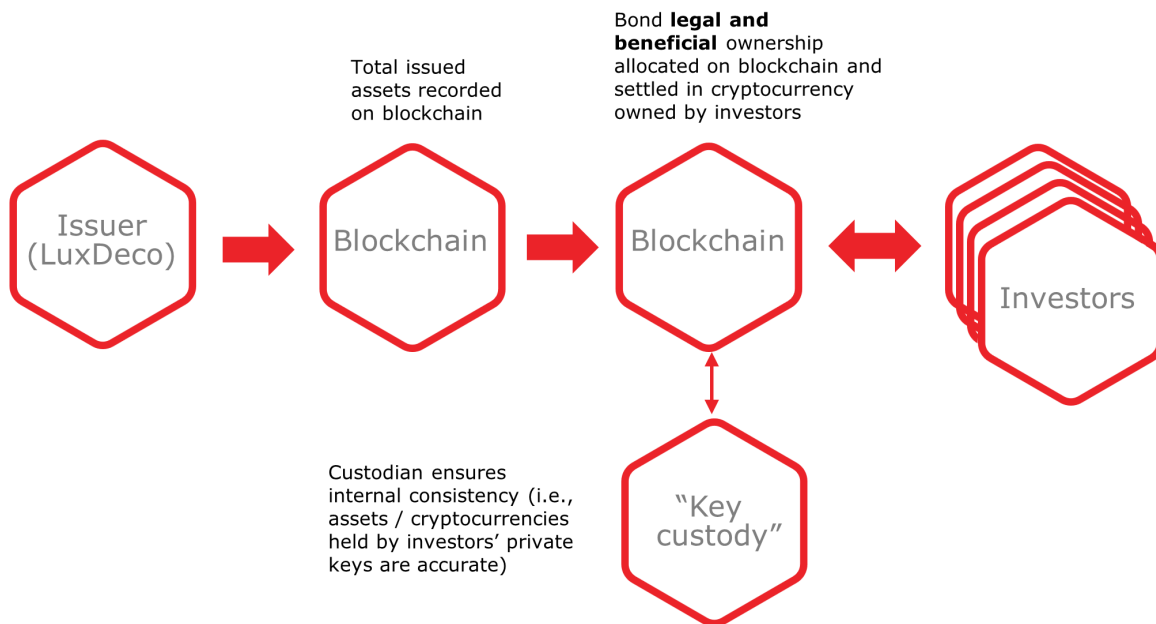
"We will be able to make predictions on market conditions and how to optimize the structure of financial instruments for different conditions, different markets and different participants."

 **VIC ARULCHANDRAN**
Chief Operating Officer
Nivaura

After this impressive start, Nivaura raised \$20 million in a 2019 seed round and invested the proceeds in a new automation platform. It combined blockchain, machine learning, and a general-purpose legal mark-up language to streamline and automate the manual processes of issuing and administering new financial instruments.³⁶ Vic Arulchandran, Nivaura’s chief operating officer, said the new Aurora platform enables institutional clients to pull together a large and evolving data pool about security issuances that can surface opportunities to reengineer processes and generate new insights about how to better structure deals. “We will be able to make predictions on market conditions and how to optimize the structure of financial instruments for different conditions, different markets, and different participants,” he said.³⁷

By largely eliminating the need for manual entry and re-entry of data at various points of the issuance process, Nivaura claims that the automated processes for new issues can collapse both the fixed costs and timeframes for standard debt deals by 60 to 80 percent. As a testament to these powerful efficiencies, Nivaura closed several partnership agreements in 2020, including new deals with Clifford Chance (an international law firm), the London Stock Exchange Group (LSEG), and DBS Bank in Singapore. With the LSEG, Nivaura further

Figure 3: The experimental bond issuance on blockchain



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Nivaaura's next priority is to make its automation platform the infrastructure of choice for issuing new debt securities.

underlined the validity and efficiency of its technology in a \$7 billion syndicated bond issuance on the London Stock Exchange.³⁸

Nivaaura's next priority is to make its automation platform the infrastructure of choice for issuing new debt securities. "Our goal is to weave ourselves into the fabric of financial markets," Arulchandran said. "We have been successful in conducting a number of POCs and one-off issuances. The next step is to do this at scale. We want to deploy our technology to issue new securities on a daily basis."³⁹

Blockchain and identity management

Rising concerns about the erosion of privacy have given rise to growing calls for a wholesale shift in how we define and assign ownership of data assets and how we establish, manage, and protect our identities in a digital world. Blockchain has long been posited as the ultimate platform to support a fully autonomous, decentralized, and secure identity management solution for the digital age. While genuine solutions for a self-sovereign model of identity are more concept than reality a handful of identity management innovations are showing the way forward.

Among the hallmarks of e-Estonia is the blockchain-enabled Estonia ID card: a cryptographically secure digital identity card that unifies access to a mind-boggling array of services.⁴⁰ Citizens can order prescriptions, vote, bank online, review school records, apply for state benefits, access medical and emergency services, file their taxes, submit planning applications, upload their will, apply to serve in the armed forces, travel within the European Union without a passport and fulfill around 3,000 other functions. Business owners can use the ID card to file their annual reports, issue shareholder



Fingerprint Sensor Access with Fingerprint by Suzanne Plank, 2019, used under Pixabay license. Cropped to fit.



Estonia's digital ID card is a significant advance on the highly siloed identity management systems of most countries.

documents, apply for licenses, and so on. Government officials can use the ID card to encrypt documents; review and approve permits, contracts, and applications; and submit information requests to law enforcement agencies.

Estonia's digital ID card is a significant advance on the highly siloed identity management systems of most countries. The ultimate identity solution for the digital age, however, must be independent of any corporation, government, or other third party and not subject to the agency risk of executives or political parties. It must interoperate with *and outlast these institutions*. It must also *outlive its users* and enforce their right to be forgotten. And so it must separate data rights from the actual data, so that the rights holder could delete it. To be inclusive, it must be user-friendly with a low-tech mobile interface and low-cost dispute resolution. Blockchain could serve as its foundation, with a broad coalition of public and private actors to make it happen.

Blockchain and the Internet of Things

Thanks to IoT, we have unprecedented access to new data streams that can help public and private sector leaders manage the world of physical assets, from auto parts in supply chains to infrastructure assets like roadways, pipelines, bridges, and buildings. The many new sensing capabilities will unleash countless real-time reporting opportunities. Scientists can use distributed sensor networks, geographical information system mapping, and the data these tools generate to revolutionize our ability to model the world, giving us new insights into phenomena and the ability to forecast trends (e.g., climate change) with greater accuracy. Increasingly timely and granular feedback loops will also revolutionize transportation, infrastructure management, and international trade (e.g., sensors monitoring everything from hospital equipment to the structural soundness of bridges and buildings, sniffing out pesticides and pathogens in food, even "recognizing" and adapting to the person using them).

Pervasive computing is already powering quantum leaps in the volume of data available to public- and private sector decision-makers.

Pervasive computing is already powering quantum leaps in the volume of data available to public- and private sector decision-makers. But copious new data also raises new questions. For example, how will these distributed devices and digital assets interoperate? Where should data reside? How can organizations securely use these data at scale? Many see a vital role for blockchain in solving these challenges.

In 2015, IBM and Samsung announced a POC called ADEPT (Autonomous Decentralized Peer-to-Peer Telemetry), using blockchain-like technology as a backbone of a decentralized network of IoT devices.⁴¹ With ADEPT, a blockchain serves as a public ledger for connected devices; no central hub mediates communication among them. The devices can communicate among themselves autonomously to manage software updates, bugs, or energy.









In another example, Mobility Open Blockchain Initiative (MOBI) is a nonprofit using blockchain, IoT, AI, and related technologies to make transportation more efficient, affordable, greener, safer, and less congested. Backed by many of the world’s largest vehicle manufacturers, infrastructure providers, and tech companies, the consortium is focusing on blockchain-based standards for vehicle-to-vehicle and vehicle-to-infrastructure communications and payments.

MOBI is focusing on blockchain-based standards for vehicle-to-vehicle and vehicle-to-infrastructure communications and payments.

According to MOBI, these standards will permit any smart device—vehicles, road sensors, toll bridges, or other pieces of mobility infrastructure—to have an identity, communicate, and participate autonomously in economic transactions.⁴² In a recent analysis, Juergen Reers, Stephen Zoegall, and Pierre-Olivier Desmurs of Accenture predict that these transactions will become a multitrillion-dollar global ecosystem that enables new pay-as-you-go mobility services with blockchain providing the infrastructure for data sharing and security across manufacturers, suppliers, and other relevant parties.⁴³

Table 2: Six levels of vehicle autonomy

| | | | | | |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
|  |  |  |  |  |  |
| 0 | 1 | 2 | 3 | 4 | 5 |
| No automation | Driver assistance | Partial automation | Conditional automation | High automation | Full automation |
| The driver controls all aspects of driving, even with enhanced warning or intervention systems. | The driver controls the vehicle, but the vehicle design includes some driving assistance features. | The vehicle can steer and manage speed, but the driver must monitor the vehicle and maintain situational awareness. | The driver need not maintain situational awareness but must be ready to take control of the vehicle. | The vehicle can perform all driving tasks under certain conditions; the driver has the option of taking control of the vehicle. | The vehicle can perform all driving tasks under all conditions; the driver may have the option of taking control of the vehicle. |

Source: Figure entitled, "SAE [Society of Automotive Engineers] Automation Levels," *Preparing for the Future of Transportation: Automated Vehicle 3.0*, letter by Sec. Elaine L. Chao, US Dept. of Transportation, 4 Oct. 2018, p. vi, accessed 28 July 2019. Adapted courtesy of the US Dept. of Transportation. Not copyrightable in the United States.



Recommendations for harnessing enterprise blockchain

In less than a decade, early movers in enterprise blockchain adoption have moved from cautious tinkering in the sandbox to a confident unleashing of the full power of DLT.

In less than a decade, early movers in enterprise blockchain adoption have moved from cautious tinkering in the sandbox to a confident and transformational “this is how business is done” approach to unleashing the full power of DLT.

In these pages, we documented the pathbreaking work of enterprise blockchain pioneers in industries ranging from automotive manufacturing to insurance to construction. We saw how Blockscale and ChromaWay are building more efficient property markets with blockchain registries for land titles; how Everledger and its partners in the diamond industry are harnessing blockchain to bring greater transparency and traceability to the diamond supply chain; how B3i’s decentralized data management solutions are streamlining industry workflows in the catastrophic reinsurance market; and how companies like Intelliwave building distributed ledgers into its solutions for automating the administration of complex construction projects.

To showcase how transformational advances in asset registration, traceability, and automation can work together, we highlighted how Circular and its partners in the automotive industry built an end-to-end solution for ethically sourcing the critical minerals that power the batteries for a new generation of EVs. We also examined some of the blockchain innovations on the horizon, including blockchain-enabled applications for financial markets, digital identities, and the IoT.

Here we offer some concluding thoughts and recommendations for how enterprise leaders can position themselves to take advantage of blockchain-enabled innovation today and the next waves of innovation as they unfold.

A first step in fostering the adoption of new solutions is to ensure decision-makers appreciate the broader applications of blockchain.

Educate senior executives about opportunities for blockchain-enabled innovation. Traditional industries like diamond manufacturing and construction tend to associate blockchain with cryptocurrencies. According to Everledger’s Leanne Kemp, a first step in fostering the adoption of new solutions is to ensure decision-makers appreciate the broader applications of blockchain. “When we started out with Everledger in 2015, awareness of blockchain was still growing and mostly in relevance to Bitcoin,” said Kemp. “We had to educate traditional industries on what we were developing and work hard to understand the potential applications to the problems that needed solving in traditional industries.”⁴⁴ Knowledge networks that bring industry, solution providers, and researchers together could play a valuable role in raising awareness of the broader applications of blockchain that we have outlined in this report.

Identify use cases for blockchain adoption and build the business rationale for investment. Domains where blockchain implementations will be highly impactful for enterprises include:



- » Projects where digital records of importance—such as digital identities, land titles, contracts, and transactions—must be audited and carefully protected.
- » 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.
- » Projects in which smart contracts can automate processes and transactions when contractual conditions are met and validated (e.g., issuing a new financial instrument or processing a payment when a piece of work is completed).
- » Large and complex projects or industry processes where success depends on the ability to efficiently mobilize people, knowledge, and resources across organizational boundaries.

"The cost to our clients of our technology is more than offset with benefits and savings associated with the reduction of risk, fraud, and friction across the supply chain."

 LEANNE KEMP
Founder and CEO
Everledger

A well-defined use case will help ensure technology and business leaders come armed with a compelling business case for senior management. The use cases for construction, insurance, and the EV and diamond supply chains are premised on the ability of blockchain to deliver bottom-line impacts by solving significant pain points in the respective sectors. For example, in building a global digital ledger for diamonds, Everledger's business model rests on providing a zero-sum game for the industries it serves. "The cost to our clients of our technology is more than offset with benefits and savings associated with the reduction of risk, fraud, and friction across the supply chain," said Kemp.⁴⁵

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. Looking back at the evolution of B3i, Ken Marke attributes its success to the willingness of diverse industry participants to rally behind a shared pilot project designed to remove the inefficiencies in the reinsurance market.

*Consortia don't usually work. Members often don't agree on the strategy, and there are competitive issues and disputes over intellectual property. But everyone could get on a board with a project to address those inefficiencies. And everyone wanted to come up with a better way to handle data and transactions between multiple parties.*⁴⁶

Any enterprise 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.

Solve the hard problems to differentiate your blockchain solution. Hosted blockchain services provided by Oracle, AWS, IBM, and others are making it easier than ever to deploy a solution.



"The real challenges are mapping the supply chain, making sure that the data is reliable, and enforcing some discipline on who's allowed to do it and whether you can trust it."

 DOUGLAS JOHNSON-
POENSGEN
Founder and CEO
Circulor

Streamlining the administrative overhead with blockchain will free up managers for problem-solving, boosting productivity, and helping clients achieve better project outcomes.

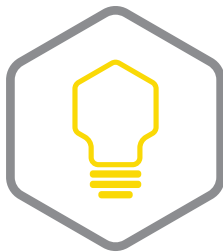
According to Johnson-Poensgen, getting the blockchain infrastructure up and running represented the most straightforward aspect of Circulor's journey. The harder problems in supply chain traceability all gravitate around the need to ensure that the data recorded on the blockchain is reliable. These problems include mapping the end-to-end supply chain, carefully vetting participants, developing protocols to safeguard the security and veracity of the data, and training personnel on the ground to implement the traceability solution. The ability to address these challenges assuredly is what makes Circulor a valuable and trusted partner for automakers like BMW, Polestar, and Volvo. As Johnson-Poensgen put it, "The real challenges are mapping the supply chain, making sure that the data is reliable, and enforcing some discipline on who's allowed to do it and whether you can trust it."⁴⁷

Foster organizational agility to complement blockchain adoption. The Project Management Institute's *2021 Pulse of the Profession* identified organizational agility—and the emergence of so-called gymnastic enterprises—as increasingly important to project success.⁴⁸ The case studies highlighted in this report also underscore the importance of agility in how enterprises respond to and manage change. Regardless of the industry, pursuing blockchain-enabled transformation will often require fundamental changes to how entities contract with each other and how they interact with and manage data. The automotive industry must accept, for example, that blockchain-enabled traceability will infuse greater transparency and integrity into its methods for sourcing critical minerals and manufacturing EV batteries. Participants in the B3i consortium, on the other hand, must accept that the ability to optimize and automate market-wide processes comes with a commitment to securely sharing sensitive data across enterprise boundaries. In short, these case studies demonstrate that change management capabilities and the capacity to adapt rigid assumptions and processes are necessary components in the adoption of disruptive technologies like blockchain.

Leverage blockchain-enabled efficiencies and automation to redefine roles and build competitive advantage. In a recent report, the Project Management Institute found that 94 percent of organizations identified as having well-formalized processes in place. They also reported being "often or consistently adaptable" in the face of unforeseen strategic challenges.⁴⁹ Formalized processes foster adaptability by allowing organizations to react quickly, adjust with agility, and implement strategic initiatives successfully. We explored use cases in financial markets and construction that showed how blockchain-enabled process automation can help executives focus their energies on leading and executing strategic initiatives in their organizations. In construction, streamlining the administrative overhead of contracts, materials management, and other administrative duties with blockchain will free up managers to spend less time on paperwork and reconciliation and more time on problem-solving, boosting productivity, and helping clients achieve better project outcomes.



Meanwhile, as automation takes hold in the structuring and issuance of new financial instruments, the value-add and competitive advantage for lawyers and financial advisors will change. “Automation and technologies like blockchain will shakeup the industry and lead to a redefinition of roles,” said Nivaura’s Arulchandran. “Some participants are worried that their jobs could be automated. Others may see their value-added diminished by the ability of blockchain to register and clear financial transactions.”⁵⁰ Because financial instruments and market standards are always evolving, Arulchandran sees an ongoing need for legal and financial experts to advise their clients on the kinds of instruments and deal structures that will meet their objectives.



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Anthony D. 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 needed for a twenty-first century workforce. His work on technology and innovation has appeared in such publications as the *Huffington Post*, *Harvard Business Review*, and *The Globe and Mail*.

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About the Brightline Initiative

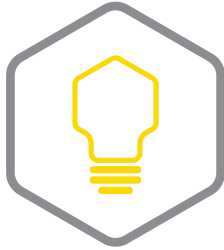
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About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is an independent, global think tank established to help realize the new promise of the digital economy. For several years now, we have been investigating the transformative and disruptive potential of blockchain technology on business, government, and society.

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 protocols, applications, and ecosystems and their strategic implications for enterprise leaders, supply chains, and industries.

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.

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