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Using blockchain to drive supply chain innovation

A series exploring Industry 4.0 technologies and their potential impact for enabling digital supply networks in manufacturing.

Contents

Do you need blockchain in your supply chain? Blockchain can be used to improve the transparency and traceability of material throughout the supply chain. It will be particularly valuable in situations without a central agency of trust when each party does not want to directly exchange information.

Of interest because: As consumers demand more transparency and the complexity of supply chains increase, an effective and inexpensive way to trace each material used in the final product is important in building confidence with increasingly environmental and socially conscious consumers.

Could improve your supply chain by: Increasing visibility of material throughout the entire supply chain; decreasing administrative costs; and authenticating against counterfeit products.

Challenges: Technology is still in early trials in supply chains; industry is still learning about security, cost, and implications; continued difficulty linking blockchain to physical objects; complexity convincing all stakeholders to adopt blockchain.

Next steps: Continue to monitor advancements in blockchain, which have the potential to improve supply chain transparency and offer new opportunities to reduce sourcing risk, decrease administration cost, and improve stakeholder engagement.

Deloitte Consulting LLP's Supply Chain and Manufacturing Operations practice helps companies understand and address opportunities to apply Industry 4.0 technologies in pursuit of their business objectives. Our insights into additive manufacturing, the Internet of Things, and analytics enable us to help organizations reassess their people, processes, and technologies in light of advanced manufacturing practices that are evolving every day.

What is blockchain?

Overview

Blockchain is a technology that can allow authenticated data communication between each player in a supply chain without the intermediation of a trusted central organization. By verifying and adding data in real time, blockchain can increase transparency across a supply chain. According to Bank of England, a blockchain is "a technology that allows people who don't know each other to trust a shared record of events."[1]

Overview	
Characteristics	• Inherently traceable, time stamped, censorship resistant, distributed ledger, near real time
Potential value drivers	• Transparency and material traceability • Reduced administrative costs • Lowered risk of fraud and gray-market trading • Better control of outsourced contract manufacturing
Scope	• Using blockchain to connect each stakeholder in the supply chain for information exchange
Technology substitutes	• RFID • Current ERP systems • Git and other distributed databases • Cloud-based solutions • Ripple Transaction Protocol

Technology function and characteristics

Blockchain is a digitally distributed ledger or database of records, transactions, or executed events that are shared across the participating parties. Each transaction in this system is time stamped and verified by a consensus of a majority of participants in the system.

A blockchain is made of a "chain" of information-storing "blocks," where each block contains information such as transactions made, amounts, and parties involved. It is possible to access all previous blocks linked together in the chain, so a blockchain database retains the complete history of all the assets and instructions executed since the very first one. This is useful because blockchain facilitates authenticity by checking with various users that their copy of the blockchain matches with all of the others. Every transaction is validated by a network of users called "miners." Miners must perform large computations to show "work" before being allowed to add a new block to the chain, and the large amount of work required to create each block, in theory, would likely discourage someone from creating the entire blockchain with tampered data to replace the authentic copies.

This distributed verification method promotes data integrity and transparency, dubbing the technology as an enabler of "trustless trust," meaning that parties don't need to know or trust each other to participate in exchanges of value with absolute assurance and reputable intermediaries. Blockchain also does not have a central point of failure because all participants will have a copy of the ledger, making it more durable than a centralized system.

Blockchain can also be programmed with embedded instructions, such as if-else and if-then statements, to carry out actions when certain conditions are met. These instructions can be used to program "smart contracts," which link the information in a blockchain to consequences (e.g., transfer penalty fees) when the agreed terms are not met.

Common types of blockchain

	Public blockchain	Hybrid/consortium	Private blockchain
Overview	Fully decentralized with no central authority; "proof-of-work" or "proof-of-ownership" is used to ensure record authenticity	Quasi-centralized where a consortium of entities controls the record authenticity	A central authority acts as a trusted intermediary to control and ensure record authenticity
Permission	Permissionless—anyone can read and write	Permissioned—selected participants can make changes	Permissioned—write permissions are centralized to one entity
Transaction verification	Records are verified by majority of the "miners" reaching consensus on the authenticity	Transactions are verified by the consortium	Central authority verifies transactions
Data storage	Records are distributed; a copy of the entire record is available to all users of the peer-to-peer network	Records are distributed throughout the consortium	Records are stored by the central authority
Transaction cost	Low cost for transactions	Transaction cost agreed to by the consortium	Transaction cost dictated by one entity

Technology evolution and outlook

Bitcoin, the earliest blockchain implementation, has triggered widespread experimentation of blockchain led primarily by the financial services industry. In 2015, Nasdaq and OMX Group Inc. worked with a blockchain startup, Chain, to pilot and test blockchain technology for trading of shares in Nasdaq Private Market.[2] Separately, Visa Europe, the Commonwealth Bank of Australia, RBS, and many of the UK's high street banks have all announced that they are working on their own proof-of-concepts using blockchain.[3,4,5]

As blockchain gains publicity, large corporations and startups alike are inventing new uses of the technology outside of the financial services industry. Many organizations are already experimenting with blockchain solutions to fulfil their needs. According to a recent Deloitte study, 35 percent of respondents surveyed are planning aggressive deployments of blockchain in 2017.[6] Many startups have already started doing so. Provenance, a supply chain transparency startup, recently completed a six-month pilot for tracking responsible sourcing of tuna in Indonesia via blockchain.[7] Monegraph, a startup launched in 2014, uses blockchain to secure the usage and sharing rights of digital media such as video clips or brand-sponsored content and enable sharing of revenue across the media creators, publishers, and distributors. Skuchain builds blockchain-based B2B trade and supply chain finance products targeted toward the $18 trillion global trade finance market that involves numerous entities including buyers, sellers, logistics providers, banks, customs, and third parties.[8]

Blockchain in the supply chain

Implementing blockchain solutions can help participants to record price, date, location, quality, certification, and other relevant information to effectively manage the supply chain. The availability of this information within blockchain can increase traceability of material supply chain, lower losses from counterfeit and gray market, improve visibility and compliance over outsourced contract manufacturing, and potentially enhance an organization's position as a leader in responsible manufacturing.

Benefits of blockchain in the supply chain

Value drivers for blockchain

Blockchain can provide increased transparency, as well as reduced cost and risk across the supply chain.

Primary potential benefits

Increase traceability of material supply chain to ensure corporate standards are met

Lower losses from counterfeit/gray market trading

Improve visibility and compliance over outsourced contract manufacturing

Reduce paperwork and administrative costs

Businesses can improve their supply chain management through more transparent and accurate end-to-end tracking. Over 90 percent of consumers surveyed list food product transparency as a critical factor impacting their purchase and expect manufacturers to provide the necessary information.[9] An estimated 55 percent or more of consumers will pay a premium for services from companies promoting social responsibility.[10] With blockchain it is possible to digitize physical assets and create a decentralized, immutable record of all transactions, making it possible to track the asset from production to delivery or use by the end user and provide greater product history and transparency. This provides more visibility to both businesses and consumers into the products they consume.

Blockchain's transparency may also help reduce fraud for high-value goods such as diamonds and pharmaceutical drugs. According to the Organisation for Economic Co-operation and Development, counterfeit goods account for over $450 billion in trade annually.[11] Furthermore, an estimated 10–30 percent of medicines sold in developing economies are counterfeits, leading to hundreds of thousands of deaths and billions of dollars in revenue losses globally.[12,13] Blockchain could help companies understand how ingredients and finished goods are passed through each subcontractor and reduce profit losses from counterfeit and gray market trading, as well as increase confidence for end-market users by reducing or eliminating the impact of counterfeit products.

Furthermore, businesses can maintain more control over outsourced contract manufacturing. Blockchain provides all parties within a respective supply chain with access to the same information, potentially reducing communication or transfer data errors. Less time can be spent validating data and more can be spent on delivering goods and services—either improving quality, reducing cost, or both.

Finally, blockchain can streamline administrative processes and reduce costs by enabling an effective audit of supply chain data. Processes involving manual checks for compliance or credit purposes that may currently take weeks can be accelerated through a distributed ledger of all relevant information.

Secondary potential benefits (intangibles)

- Strengthen corporate reputation by providing transparency of materials used in products
- Improve credibility and public trust of data shared
- Reduce potential public relations risk from supply chain malpractice
- Engage stakeholders

In today's social media landscape, a single post regarding labor issues in the manufacturing process or unapproved subcontracting (i.e., subcontract manufacturer outsourcing the job to another factory without notifying the brand) could result in a public relations disaster. Proactively managing the supply chain and getting ahead of the curve in traceability can help build a reputation as a leader in responsible manufacturing. Presenting data verified by a blockchain can contribute to improved public trust in the supply chain data. Transparency can give more weight to quality checks and build authenticity for data shared between the supply chain partners.

Implementing blockchain solutions in the supply chain requires cooperation from all stakeholders. This could be presented as an opportunity to rethink stakeholder relationships and create more collaborative ecosystems.

Case studies: Supply chain transparency

Blockchain in shipping logistics
A shipping company used blockchain to manage freight tracking, providing buyers, sellers, and officials with a mechanism to track goods shipped around the world. Products traveling across borders may require review and approvals from up to 30 parties before arrival, creating a large amount of paperwork and creating opportunities for fraud at multiple points in the process—leading to billions of dollars in maritime fraud each year.[14] Through collaboration with customs authorities, the shipping company streamlined the approvals process by creating a secure record of transactions and approvals and reduced the time needed to transport goods. Similar use cases illustrate blockchain has the potential to reduce administrative and logistics timelines in shipping by more than 85 percent—from more than one week to less than one day.[15]

Blockchain in food production
A startup is using blockchain as part of an effort to increase supply chain transparency in the second-largest traded commodity in the world—coffee beans. The company is using a distributed, decentralized protocol for real-time mobile transactions, recording data about the transactions and allowing all involved parties to access the record of payments at any time. The system increases transparency as the coffee beans progress through the supply chain and helps to ensure farmers receive proper fair-trade payments.[16]

Blockchain in luxury manufacturing
A logistics company has introduced a cloud-based blockchain solution to digitally certify diamonds and protect against unauthorized tampering with supply chain records. Diamonds are held to strict certification requirements to ensure they are sourced ethically, but fraudulent certificate reports and insurance claims can disrupt the safeguards set in place. To combat this, the company uses over 40 diamond characteristics including color and clarity to create unique diamond IDs. The blockchain solution allows for immutability and security for the supply chain data and provides the necessary transparency between diamond certification houses and global diamond suppliers for the certification process. So far, the company has digitized more than one million diamonds.[17]

Blockchain in pharmaceuticals
Another promising area for blockchain solutions is provenance (tracking of assets across a supply chain) within the pharmaceutical industry. Tracking active pharmaceutical ingredients during the manufacturing process is difficult and faces increased challenges from the widespread and lucrative counterfeit drug operations around the globe. Rubix by Deloitte identified three key use cases within pharmaceuticals—how drugs are manufactured, how they move from manufacturer to end consumer, and how public safety issues for consumers are addressed.[18] Blockchain's immutability provides a basis for traceability of drugs from manufacture to end consumer, identifying where the supply chain breaks down. There is potential not only to reduce the $200 billion in losses each year but also to increase public safety and prevent some of the estimated one million deaths per year from counterfeit medicine.[19]

Criteria for evaluation and adoption

Adoption considerations

Blockchain is an emerging technology with a breakthrough potential, but achieving return on investment requires careful evaluation of both the suitability of the technology for your company's supply chain profile as well as the predictability of investment returns. The following five attributes can help shape your blockchain prototyping timing and value decision. Once a concept is agreed upon, starting with a prototype on a test network with dummy data before piloting the blockchain externally can be done to prove the concept before investing.

Traceability needs

Whether blockchain prototyping makes sense depends on the traceability needs of the supply chain.

Key questions in this category may include:
- What is the traceability need?
- Who would be entering data?
- Who would need access to the data?
- What needs to remain confidential?

Material characteristics and production profile

Blockchain and the data stored in it exist only in the digital realm. Interfacing the data tracked in the blocks to the physical goods being traced requires other technologies. Blockchain leaders are experimenting with technologies like Internet of Things or smart sensors. Their use depends on characteristics of the materials being tracked.

Key considerations in this category:
- What size and shape is the physical material being tracked?
- What technologies are available to connect the physical material to its digital signature equivalent?
- What physical and chemical transformation is applied to the materials tracked during the manufacturing process?
- Is the technology connecting the physical material to the blockchain tamper proof?

Supply chain layers and partners

Achieving consensus to implement blockchain in supply chains with multiple layers and more partners involves considerably more stakeholder engagement. Incentives and openness of sharing between the partners determine the risk, feasibility, and value of using blockchain. Blockchain can be an effective solution where there is a lack of central agency of trust.

Questions in this category may include:
- How many manufacturing or supply chain layers are involved in the process?
- Are you in an industry where the supply chain partners might be willing to follow your lead or collaborate with you on this?
- Are you and the partners in need of a central agency of trust?
- Is there risk for multiple partners in the system to collude and change the records?

Technology environment

Implementing blockchain requires a change in the data record systems of each party involved to a shared common data structure.

Key questions:
- What is the effort needed to connect to the current systems and data structures used in your company and your partners'?
- How will you transition from the current data structure to the blockchain data structure?
- What geographies do the materials flow through during the supply chain and is it easy to add a technology interface to the Internet in these environments?
- What customizations are needed to your current systems and data structures?

Regulation

Some areas of blockchain implementation are highly contingent upon supporting regulations, including property records, legal contracts, and disintermediation of financial institutions.

Key questions:
- Which countries does the supply chain span?
- Will blockchain smart contracts be considered legally binding in these countries?

Current limitations and potential risks

Blockchain is still a nascent technology, thus its limitations and improvements are continuously being discovered and developed. Some limitations and potential risks today include:

1. **Integration concerns:** Blockchain solutions require significant changes to—or complete replacement of—existing systems.

   Potential mitigation: Develop a long-term plan to identify transition requirements for systems required to support blockchain adoption.

2. **Linking digital to physical:** Radio-frequency identification (RFID), 2D barcode, and near field communication (NFC) are used today to link to physical product. However, to ensure flow of information, all steps of the supply chain and all products will have to be tagged digitally, requiring an overhaul in today's supply chain practices.

   Potential mitigation: Start strategizing now how to physically track objects, and add the digital tagging in existing supply chain to prepare for blockchain implementation.

3. **Control, security, and privacy:** While solutions exist, including private or permissioned blockchain and strong encryption, there are still cybersecurity breach concerns that need to be addressed before the general public will entrust sensitive data to a blockchain solution.

   Potential mitigation: Choose a blockchain solution partner carefully, work together to ensure security and privacy needs are satisfied, and test thoroughly before pilot.

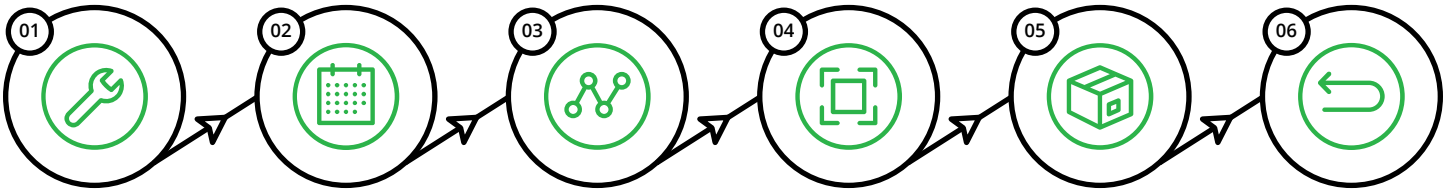
4. **Cultural adoption:** Blockchain represents a significant shift to a decentralized network, which requires the buy in of its users and operators.

   Potential mitigation: Socialize the idea of implementing blockchain in your company and collaborate with stakeholders prior to implementation to minimize excessive cost or adoption risk.

Key levers for blockchain in your supply chain

Supply chain applications

Blockchain can increase transparency at each point in the supply chain.



Develop

Gain greater access to source material data to better inform R&D material choice and enable closed-loop design

Plan

Increase opportunities for co-planning and forecast sharing between suppliers and customers, decreasing forecast and associated inventory risk

Source

Decrease sourcing and administrative costs by replacing paperwork with smart contracts and transactions recorded on the blockchain; drive "business initiatives" by enabling transparent sourcing

Make

Increase visibility and compliance of outsourced manufacturing

Deliver

Provide regulators and end consumers with a clear picture of all product steps along the supply chain journey

Return

Determine which batch to recall based on information availability; decentralize return merchandize authorization

These examples are just a few of the many opportunities to advance supply chain with blockchain. Some solutions cover the end-to-end supply chain and new blockchain solutions are being announced often that can help drive value creation and reduce costs. Deloitte's global blockchain team will be publishing a deeper-dive analysis on supply chain problems that can be solved by blockchain across various industries including automotive, food, pharmaceutical, and TMT.

Indication for action

As blockchain gains momentum, companies should keep observing the players in their industry who have begun experimenting with blockchain. Blockchain benefits greatly from the network effect; once a critical mass gathers in a supply chain, it is easier for others to jump on board and achieve the benefits. Companies should pay attention to other stakeholders in their supply chain and competitors for indication of timing to develop a blockchain prototype.

Blockchain has the potential to improve supply chain transparency and provide a wide range of potential benefits, including:

- Increased traceability of material supply chain to meet corporate responsible sourcing standards
- Lowered risk of fraud and counterfeit sourcing
- Improved visibility and compliance over outsourced contract manufacturing
- Reduced paperwork and administrative costs
- Enhanced position as a leader in responsible manufacturing

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Endnotes

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