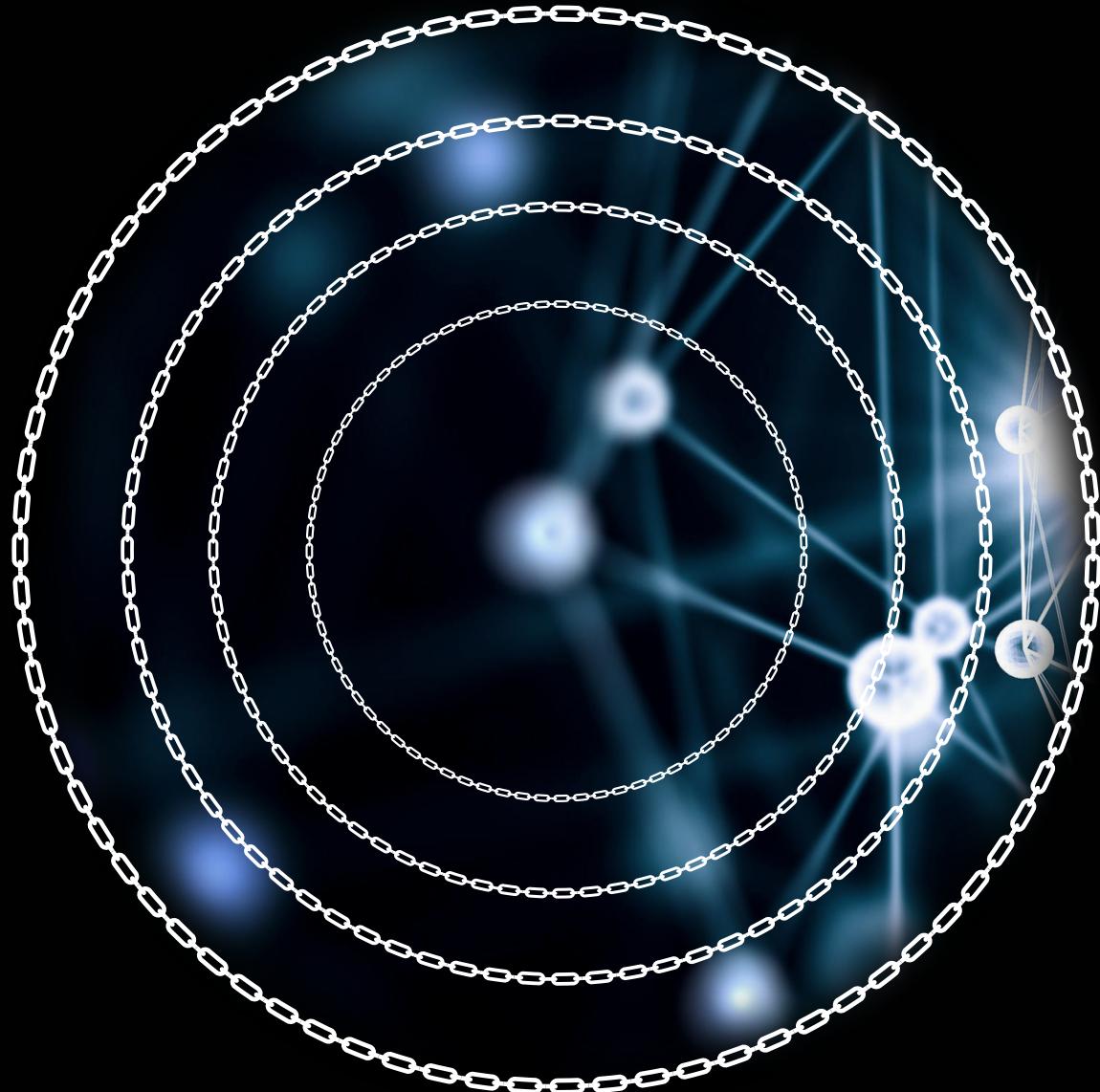


Deloitte.



When two chains combine
Supply chain meets blockchain



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Introduction

In an increasingly digitised world, emerging technologies, such as blockchain, afford organisations the opportunity to drive business value throughout their supply networks. According to Eric Piscini, Principal and Global Blockchain Leader at Deloitte Consulting LLP in the US,

 Supply chains across industries and countries will be reimagined, improved and disrupted by blockchain technologies. We now have safer and more efficient ways to connect with business partners as well as to track and exchange any type of asset. The ability to deploy blockchain technologies to create the next generation of digital supply chain networks and platforms will be a key element in business success. 

Building supply chain capabilities with digital technologies can result in greater levels of performance. Blockchain is an enabling technology, which is most effective when coupled with other next generation technologies such as Internet of Things (IoT), robotic cognitive automation or smart devices.

In this paper, Deloitte's blockchain and supply chain professionals share insights on how blockchain-enabled technology can mitigate four cross-industry supply chain issues — traceability, compliance, flexibility and stakeholder management. The paper draws on use cases from the pharmaceutical industry (product tracking), automotive industry (purchasing platform) and food industry (know your supplier).

Today's supply chain challenges and how blockchain can help

Supply chains encompass the end-to-end flow of information, products and services, and money. The way these components are managed affects an organisation's competitive positioning in areas such as product cost, working capital requirements, speed-to-market, and service perception. Organisations are exploring innovative methods to streamline their supply chains to meet evolving consumer demands and optimise efficiencies. Technological advances are collapsing linear supply chains into dynamically connected and always-on digital supply networks (DSN), transforming how businesses exchange and share information and assets.

According to a Deloitte 2016 article titled '*Aligning the organisation for its digital future*', 90 percent of organisations feel they are not adequately prepared for the industry disruptions from these digital trends. Furthermore, many believe that 40 percent of Fortune 500 companies will not exist in a decade as a result of these disruptions. These findings suggest that business leaders are under growing pressure to innovate and reconfigure their supply networks, maximising value and efficiencies while reducing costs in an increasingly competitive world.

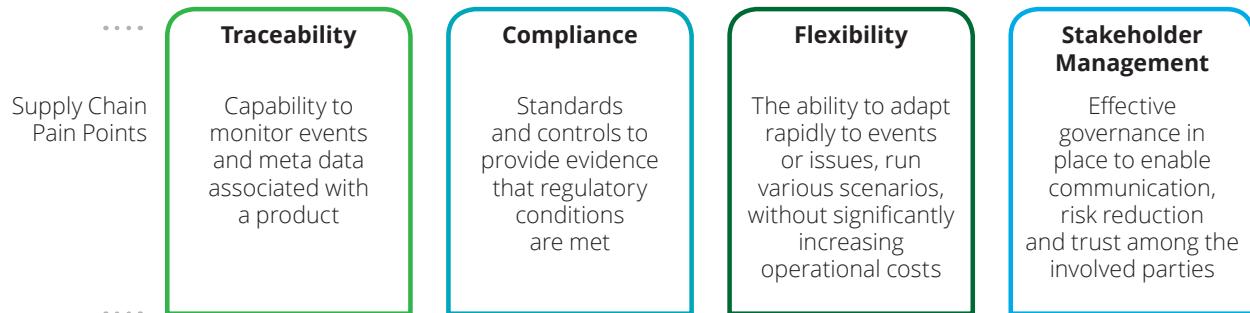
Despite DSN enhancements, paper-based processes are still common, resulting in reduced transparency and collaboration across networks. Decision making amongst supply chain actors is further complicated by disparate systems which provide limited visibility of other functions. Kai Gindner, Director at Deloitte Switzerland, states that for the past two decades, organisations have been exploring ways to enhance transparency and data sharing across their networks. These initiatives have focused

mainly on intra-organisational collaboration to gain higher efficiency.

Gindner believes companies should aim to "achieve higher levels of agility, flexibility and transparency, resulting in faster response times to the ever-changing ecosystem. The adoption of next generation technologies allows for new and more advanced collaboration models with the potential to substantially improve the supply chain performance of each node and the entire network."

These issues are felt across industries and need to be addressed before organisations can unlock the hidden value in their supply chains. David Dalton, Partner and Deloitte EMEA Blockchain Lab sponsor at Deloitte Ireland, believes that "Traceability across supply chains are one of the most compelling use cases for blockchain technology." Blockchain could be the enabler to allow organisations to more effectively tackle these problems.

Deloitte supply chain professionals have identified four key supply chain pain points that clients are experiencing across the globe:

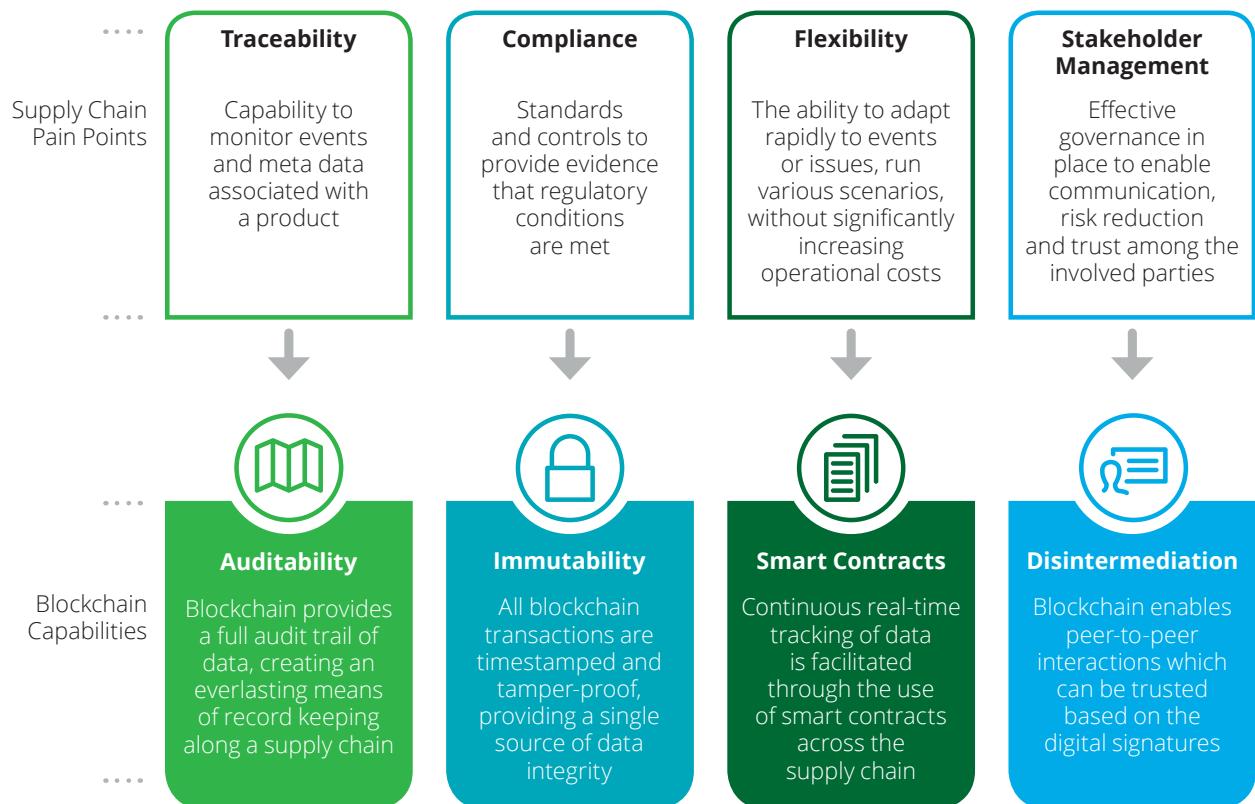


Blockchain context

Blockchain has been described as an information game changer due to its unique capabilities and benefits to provide greater information transparency. At its core, blockchain is a distributed digital ledger that lives on the internet and records transactions and events. The technology relies on well-established cryptographic principles and operates as a repository for information, which is recorded and shared through a peer-to-peer community. Within the decentralised network, all participants maintain their own copy of the ledger, referred to as a node, where they validate new entries to the chain through the use of a consensus protocol.

While one of the primary uses of blockchain is record keeping, organisations should know that blockchain is much more than simply an enterprise database. While databases are suitable for recalling ad hoc queries of large volumes of structured and relational data that require complete privacy within a single organisation's parameter, blockchain is designed to record specific transactions and events that are shared across a network of parties where transparency and collaboration is required. In a supply chain, a private or permissioned blockchain may be implemented, dictating users' ability to read and write to the blockchain.

The implementation of blockchain technology can remediate the aforementioned supply chain pain points including traceability, compliance, flexibility, and stakeholder management.



Why blockchain makes sense

Globally, Deloitte identifies blockchain as a key technology with inherent capabilities to remediate supply chain inefficiencies. Deloitte EMEA Blockchain Lab, Deloitte's blockchain centre of excellence for EMEA, deployed its first live blockchain solution with DNV GL, a business assurance provider that certifies companies' processes, products, facilities and supply chains to national and international standards, proving the capability of this technology in a production environment. Blockchain can provide a complete chain of custody for items that are stored on the blockchain, from their origin to point of sale. Furthermore, users can trust the data on the chain due to its immutability and the use of digital signatures, which enable non-repudiation capabilities.

Blockchain's tracking capabilities (including timestamping) provide a full audit trail which gives businesses increased confidence in the

authenticity and quality of goods, impacting sourcing decisions. The distributed nature of the platform allows for greater oversight and control of products while real-time tracking via smart contracts gives supply chain stakeholders the flexibility to make rapid decisions and update inventory levels on a continuous basis, thereby reducing working capital inactivity.

The Deloitte EMEA Blockchain Lab is working with clients in the retail and consumer products industry to develop pilot blockchain solutions for supply chain pain points.

The Deloitte US Blockchain Lab has developed a track and trace proof-of-concept 'TraceChain' to enhance the transparency and visibility of the chain of custody in global supply chains.

Prototype Highlight: TraceChain

TraceChain, a blockchain-based supply chain solution, enables the tracking and tracing of finished goods and materials, providing users with a high level of trust that the data they view and store on the chain is correct and has not been altered by an unauthorised party. It also provides richer data and deeper insights—in near real-time—into a production process that is predominantly paper-based and manual today, thereby reducing counterfeits and increasing trust among partners, stakeholders, and consumers.

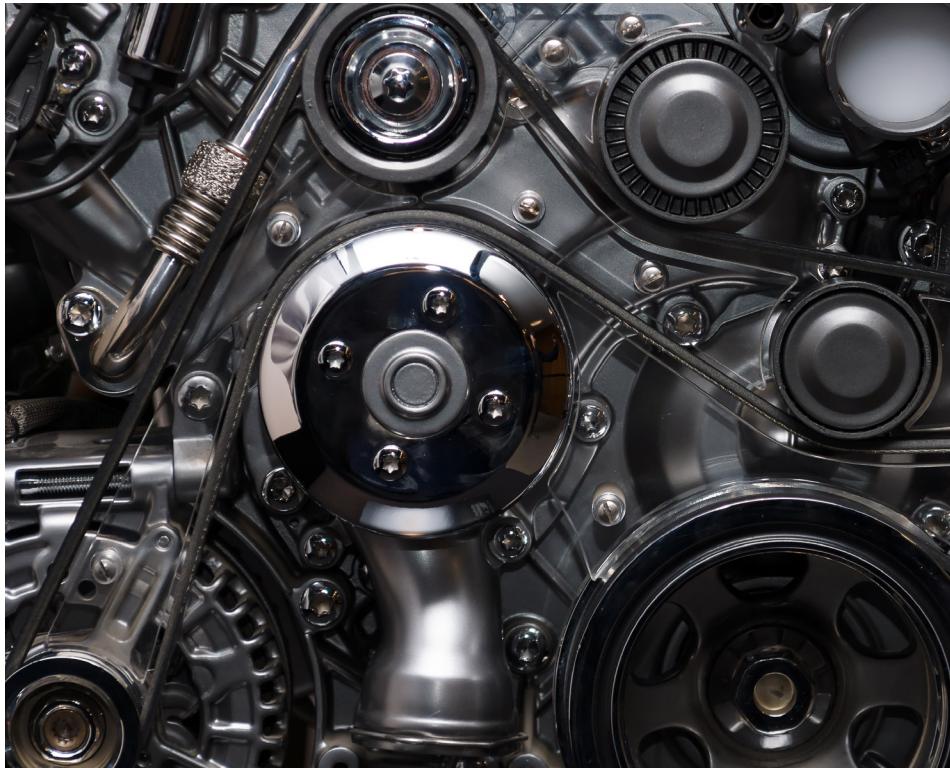
TraceChain, a blockchain-based supply chain solution was developed by the US Blockchain Lab based on interactions with our industry leaders across the Supply Chain Network.

Q:What is it?

It enables the tracking and tracing of finished goods and materials, providing users with a high level of trust that the data they view and store on the chain is correct and has not been altered by an unauthorised party.

Q:How does it work?

Leveraging blockchain, digital identities have been created for all physical goods involved in the supply chain as well as for the various actors in the chain such as suppliers, manufacturers, distributors etc. The immutable nature of blockchain enables us to record the complete chain of custody for every item that is logged to the blockchain from their origin to the point of sale. This chain of custody gives increased confidence and assurance of the authenticity and quality of goods that leads to better sourcing decisions.



Blockchain industry activity

Specific use cases have been identified by Deloitte blockchain professionals to exemplify industry-wide challenges for supply chain management. These cases examine product tracking in the pharmaceuticals sector, purchasing in the automotive industry, and know your supplier issues in the food industry.

Pharmaceutical industry

According to the World Health Organization, it is estimated that up to \$200 billion worth of counterfeit pharmaceutical products are sold globally every year and 50% of these drugs are purchased online. Counterfeiting usually occurs at the manufacturing source

where a contracted manufacturer or distributor either siphons legitimate drugs and resells them or enters counterfeit drugs into the supply chain as 'authentic' units. Although electronic drug pedigree solutions are being implemented to resolve traceability issues, these systems still rely on siloed data sources and exchanges of information via two-way interactions, suggesting that the marketplace lacks a technology solution for the problem.

In 2013, US Congress enacted the Drug Quality and Security Act (DQSA) to improve patient safety. This Act requires pharmaceutical companies to ensure the

traceability of prescription drugs throughout the entire chain by 2024. Stakeholders are under mandate to identify and report any illegitimate drugs in the network within 24 hours. Consequently, pharmaceutical companies are under increased regulatory pressure to develop innovative and effective ways to track, report, and share information with the US Food and Drug Administration (FDA) across all stages of the supply chain. Although technologies have been available for years, traceability still has nowhere near the level of granularity needed to satisfy the new regulations. To improve efficiency, a game-changer is required and blockchain could be just that.



Supply chain use case #1:

Product tracking refers to the tracing of unit level items (i.e. drugs and medicine) across the end-to-end supply chain using blockchain. All stakeholders in the

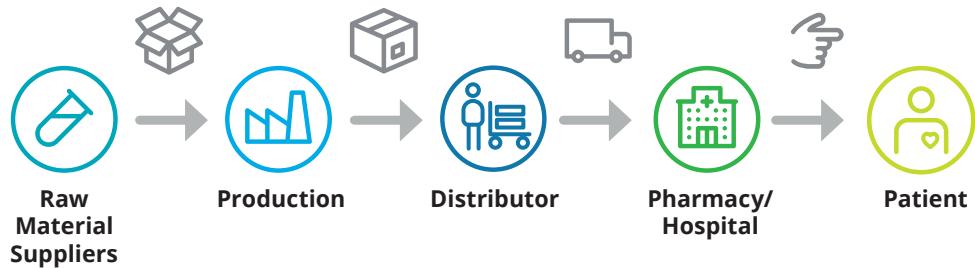
ecosystem can (1) access the provenance, (2) authenticate items, and (3) prove compliance. This is enabled by the real-time capability and distributed features associated with the platform. For example,

tracking drugs on the blockchain throughout their lifecycle—from manufacturing to patients—could facilitate counterfeit drug identification or assist drug recall management.

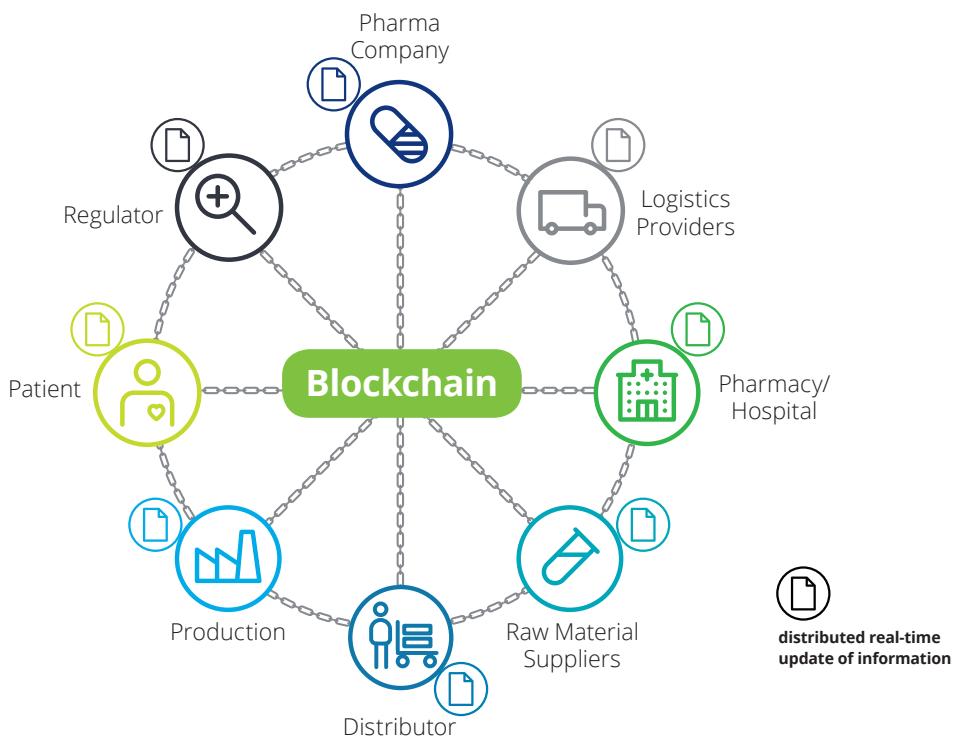


Pharmaceutical supply chain

Today



Tomorrow



How it would work

Tom Hynes, Director at Deloitte Ireland, indicates that blockchain is a potential solution that "can help track how drugs move from the manufacturer to end consumer, providing stakeholders with visibility and improving demand management, revenue forecasting and overall performance management."

Blockchain's smart contract functionality, along with the use of IoT devices, could deliver an effective, continuous drug tracking capability for pharmaceutical stakeholders where the full provenance of a unit, its conditions, authority rights, and checkpoint approvals could be accessed at any point in time, thereby enhancing the complete audit trail of each item in the chain. Any deviation, such as the drug temperature, could be captured through an IoT device, whose data would be input and tracked via smart contracts on the blockchain. The smart contract rules would then execute notifications and actions to be taken by the affected stakeholders in charge of that phase of the supply chain. Smart contracts could be coded to perform specific tasks and trigger diverse responses depending on the conditions being monitored. This would provide organisations with the ability to automatically respond to events. For example, if certain pre-defined conditions are not met, drugs could be recalled before they are released to the market. Using detection capabilities for negative conditions and recalling a drug on time could not only reduce stakeholders' compliance risk but could also prevent the sale of dangerous products and potentially protect patients from adverse events. Enhancing the contracts with a digital signature could also provide stakeholders with accurate and accountable tracking throughout a drug's lifecycle, leading to disintermediation of the chain by eliminating the need for certification processes by a sole authoritative source.

Blockchain platforms could be used to store information and enforce regulatory rules across the entire supply chain. Smart contracts used for data storage could follow a simplified structure, such as:

- Add Item—e.g., ID, location, timestamp, current stakeholder
- Update Item—e.g., ID, new location, new timestamp, new stakeholder
- Look Up Item—e.g., ID, retrieve locations, and retrieve stakeholders

IoT devices could help capture the detailed information and its flow and provide easy access to any stakeholder with credentials to retrieve the information. From a regulatory perspective, depending on legislative requirements, blockchain solutions could act as a reliable source for entities such as the FDA who could retrieve a full history of product flows via the blockchain. Using the same platform, pharmaceutical companies could prove their compliance with standards. In addition, the ecosystem could develop its own in-chain smart contracts to trigger and notify stakeholders whenever pre-defined conditions or out of the ordinary events occurred.

Product tracking is one of multiple use cases that clearly show how blockchain can be leveraged to resolve issues of traceability, compliance and flexibility where multiple stakeholders depend on one another for information sharing. Pharmaceutical companies are already investigating this game-changing technology, which promises not only regulatory compliance benefits but also end-to-end traceability.

Automotive industry

The automotive industry is in the midst of a historic change with the rise of disruptive technologies beginning to have a profound impact on infrastructure, supply chain and business models. The influx of these new technologies is driving industry players to streamline their processes, leading to shorter product lifecycles, new business

models to meet on-demand preferences, and the development of different types of vehicle and in-house vehicle services. With the emergence of more tech-oriented products and services, analysis and management of supply chains has become more difficult. Original Equipment Manufacturers (OEMs) now operate in more countries than ever before and visibility has worsened across disparate systems. To proactively address consumer complaints associated with these issues, Asim Kailash Agrawal, Manager at Deloitte Malaysia KL, reports that clients in emerging markets, like Southeast Asia, intend to leverage market intelligence in order to "detect product quality issues at an earlier stage, recall products quickly, and track the issue back to the source."

Nicholas Smith, Director at Deloitte UK, has noticed that several OEMs are already exploring the potential of blockchain technology. As it pertains to the supply chain of automobiles, he states that the blockchain provides "great potential in the tracking, tracing and provenance of parts in the upstream supply chain and in truly understanding each individual 'as-built' vehicle." Furthermore, inherent capabilities of blockchain, such as immutability and transparency of vehicle records, have the potential to create an aftermarket opportunity and a shared purchasing platform.

Supply chain use case #2: Purchasing platform:

Purchasing Platform refers to the transfer of value and interaction amongst all tier level suppliers and OEMs along the automotive value chain, facilitating the buying, selling, and reselling of all types of raw material and car parts. Stakeholders using the platform can (1) access information on raw materials, (2) buy and sell raw materials at their disposal, and (3) be held accountable for activities and checks. This is enabled by the real-time capability, smart contracts functionality, and distributed features associated with the platform.

Many OEMs today have limited visibility beyond tier 2 suppliers, and lack meaningful insight, particularly regarding raw material levels. Without the necessary supply chain knowledge or supply chain oversight areas such as working capital, cash flow levels, and data analysis are impacted, prohibiting businesses' ability to quickly adapt, plan, and buy or sell. By incorporating blockchain enabled solutions into infrastructure,

Michael Woodward, Partner at Deloitte UK, believes that analytics may be improved and trading relationships may become more transparent, enabling "an amplification of trust that is an imperative for supplier relationship management."

How it would work

A marketplace for selling, reselling, and buying raw materials could be built

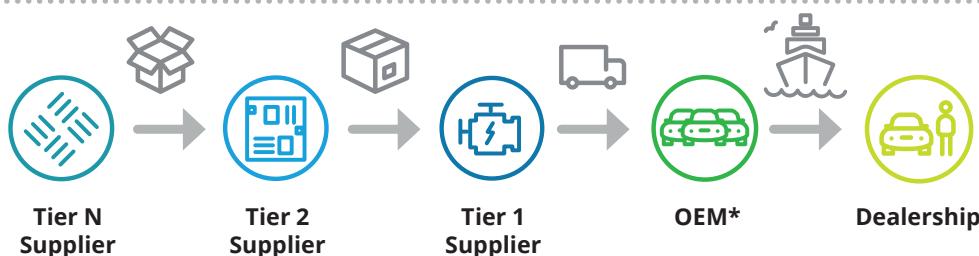
leveraging smart contracts. These self-executing blocks of code could be used to:

- Store information about supply and demand (how much is being bought and sold, how much suppliers have in stock, etc.)
- Govern sourcing decisions
- Generate requests for materials from buyers, where suppliers could bid on a shared open market platform



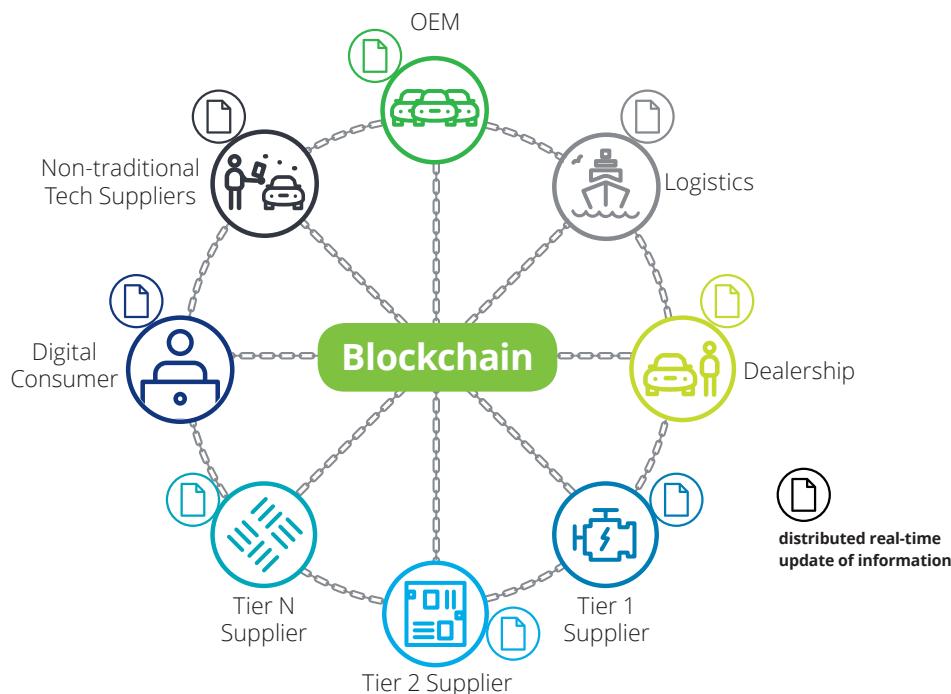
Automotive supply chain

Today



*Original Equipment Manufacturer

Tomorrow



Focusing solely on the open market platform, the exchange could flow as follows:

1. An OEM could create a request to purchase raw materials specifying criteria such as price, delivery date, etc.
2. Suppliers using the platform would be notified of the request and could submit bids including details of any conditions they might wish to impose

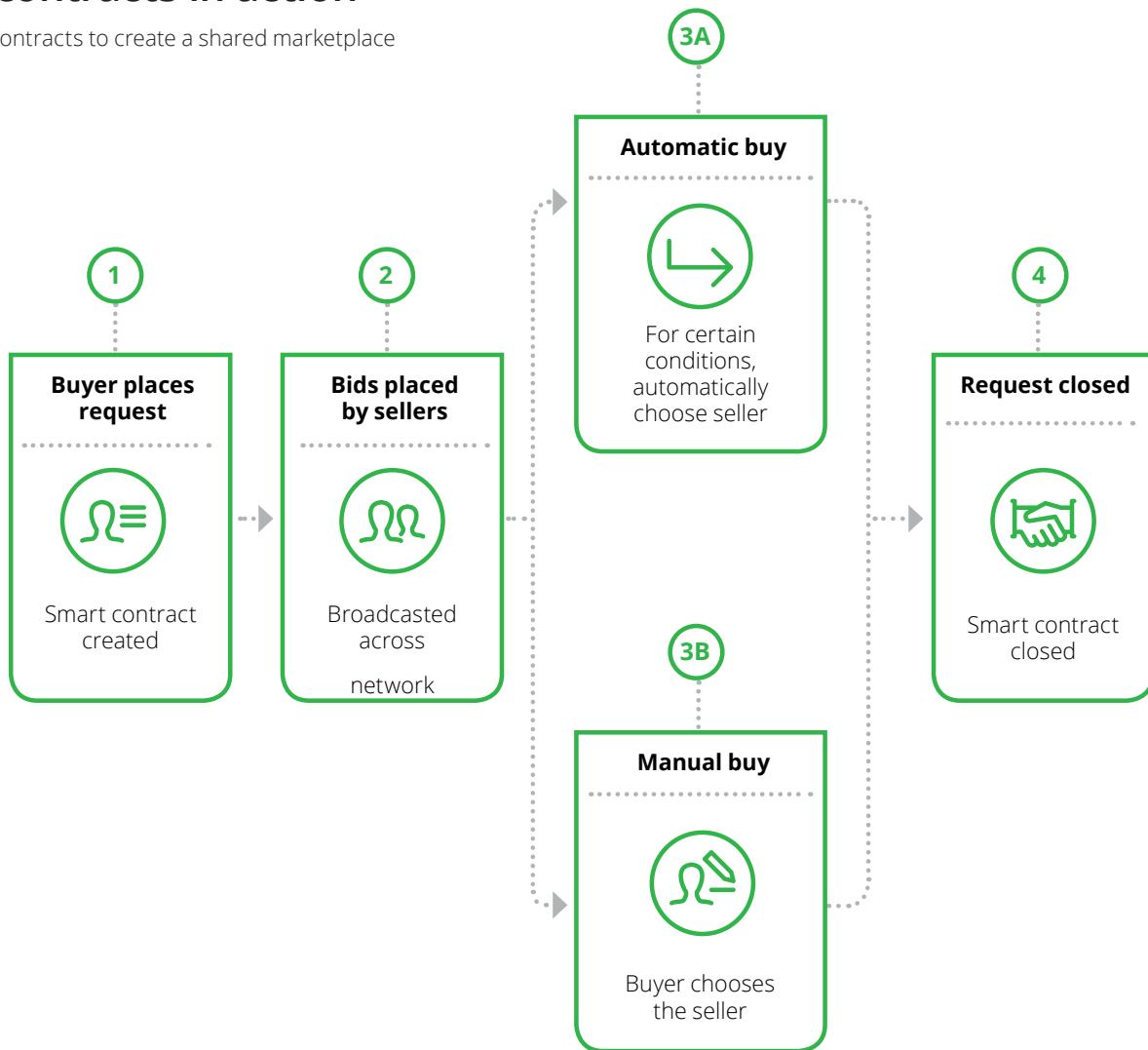
3. OEMs could then choose either to automatically select a supplier (for example, the first supplier to meet the OEM's requirements) or to select a supplier manually

Further clauses could be added to the smart contract to trigger specific events. For example, a delay in delivery could result in a penalty, which could be automatically

charged to the supplier prior to delivery. Today, stakeholders often have little or no oversight of which player is responsible for bottlenecks in the supply chain.

Smart contracts in action

Using smart contracts to create a shared marketplace





The creation of a shared marketplace, using blockchain technology, can provide users with full transparency of their inventory levels along with real-time data updates on supply and demand. Stakeholders benefit from better control of their inventory, cash flows, and sourcing decisions, and can leverage the system to prove compliance or delays were associated with certain actors in the chain if legal actions are required. According to Lance Younger, Partner at Deloitte UK, an additional benefit of using blockchain to manage automotive raw materials is the potential to de-risk the supply chain "to reduce the cost per part, across OEM operations."

As with most industries, automotive clients could significantly reduce costs and enhance visibility by introducing blockchain technology into the overall supply chain network. In addition to real-time analytics and improved recall functionalities, the inherent capabilities of blockchain merit investigation to determine how they might best benefit businesses.

Food industry

Like the pharmaceutical industry, the food sector faces increased regulatory pressure from government bodies such as the US Food and Drug Administration (FDA) and Federal Trade Commission (FTC) with standards being introduced to enforce food safety protocols and waste disposal procedures and provide visibility over food management activities across the product life cycle. The FDA's

With customers becoming more knowledgeable and demanding transparency, it is imperative for organisations to make data—such as of price, source, authenticity, or even social obligations—accessible. Blockchain-based solutions can provide assurance to not only millennials, but also digital generations, as access is granted to trusted, secure, and unaltered information. [99](#)

Food Safety Modernisation Act (FSMA), introduced in 2011, was an effort to shift food companies' focus from responding to food contamination to preventing it. Players must be able to quickly analyse data and continuously track all information to ensure they are making optimal and safe food decisions. In light of growing regulatory demands, James Cascone, Advisory Partner in Deloitte U.S., explains that blockchain "provides the traceability required to provide higher levels of assurance regarding the chain of custody of food products."

In addition, consumers are using smart devices more often for researching, purchasing, and reviewing food products from manufacturers to wholesalers to restaurants. Instant access to nearly limitless information has impacted consumers' expectations, demand for types of food products, and buying decisions. Darshini Dalal, Manager of the Blockchain Lab in Deloitte US, elaborates,

In order to respond to the influx of regulatory food standards, changing consumer demands, and increasing competition, food players will need to explore, test, and leverage innovative technologies capable of adapting and managing their supply chain activities on a real-time basis while delivering full transparency over their operations and maximum efficiency gains.

Based on client and market experience, Deloitte recognises that restaurants, retailers, wholesalers, and even suppliers may not always be able to effectively trace their food products and identify and manage the individuals they have direct and indirect relationships with across each product's lifecycle. The main use case at play, therefore, is Know Your Supplier (KYS).

Supply chain use case #3: Know your supplier

Know Your Supplier (KYS) refers to the ability to identify, verify, and endorse any stakeholder an entity wishes to conduct or continue to do business with. All stakeholders using the platform can benefit from (1) onboarding simplification, (2) a shared information repository (i.e. relationship history, provenance of goods purchased, associated supplier quality certificates), and (3) reporting capabilities. This is enabled by the real-time capability, smart contracts functionality, and distributed features associated with the platform.

According to Paul Sin, Partner at Deloitte China,

EE In China, sales volume of counterfeit products can be easily five to ten times to that of authentic ones, with alarmingly low quality and safety issues. Blockchain enables the transparency of the supply chain and provides traceability to the origins. This is not only a solid business case for sellers but also has a huge positive social impact on food safety. 99

How it would work

Food stakeholders could establish an industry-wide platform to onboard and manage supplier relationships and review the quality of food products along the entire chain. Each user in the ecosystem would use a digital identity to access and participate on the platform. Smart contracts could be created to store and manage meta-data and events associated with supplier onboarding and relationship maintenance, such as:

1. Supply chain details (i.e., product components and associated lifecycle)
2. Quality certifications approved by regulated bodies (i.e., approved body, date, expiry date, date of last testing)
3. Endorsements given by food stakeholder (i.e., wholesaler, restaurants or end consumer based their own experience, reviews of the food quality)

Food supply chain

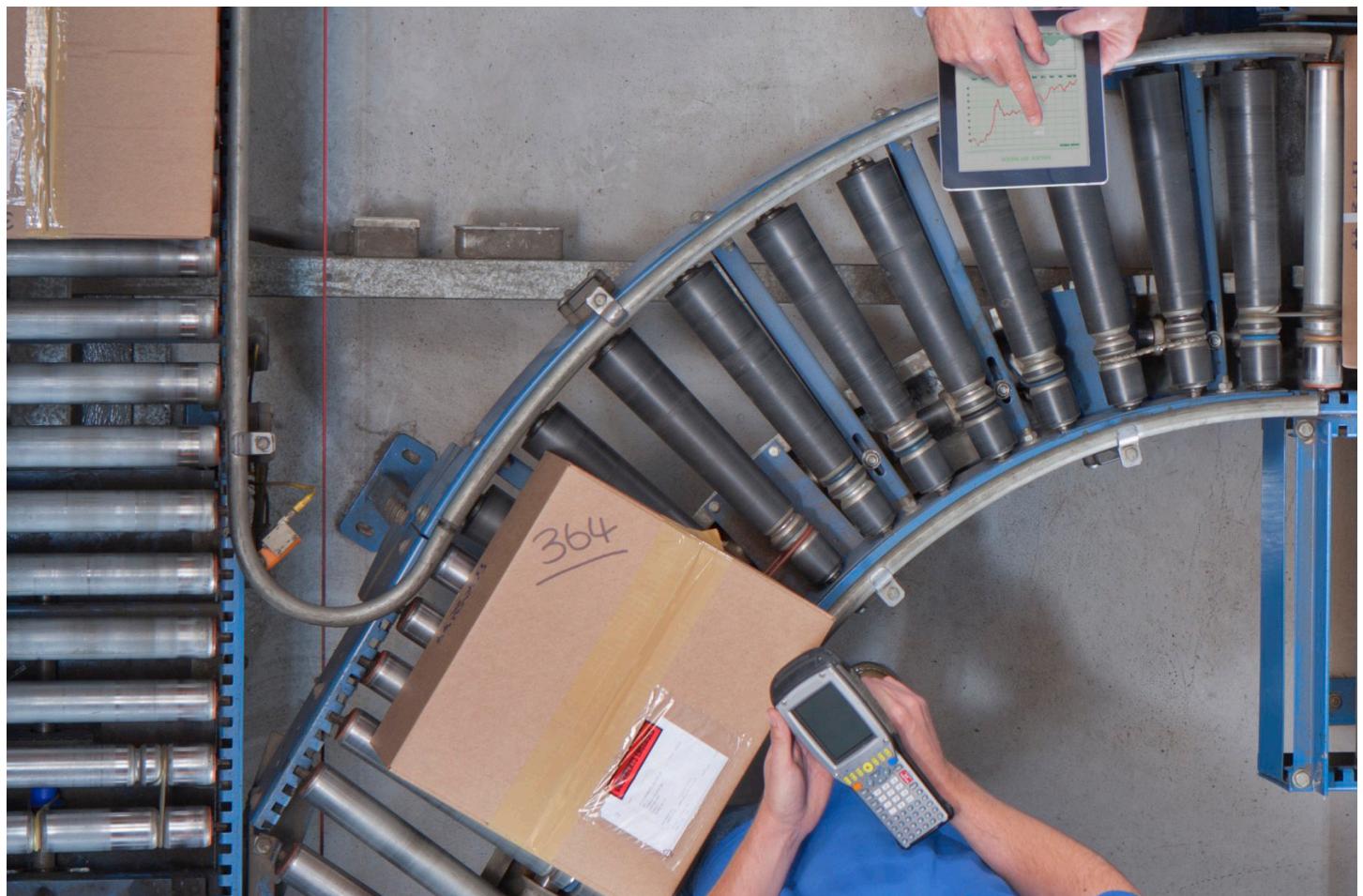


By using this onboarding platform, restaurants and wholesalers, for example, would have end-to-end visibility over the supplier relationship with real-time access to monitor and manage all supplier relationships. Currently, this is not possible in the marketplace. Platform users would have a complete audit trail of food ingredients they buy from the associated supplier and could prove the product is of specified quality by checking the quality certificates of each ingredient uploaded by the regulated bodies. Given that all information (i.e., supplier profile, certified qualifications, food materials) added to the chain is timestamped, users could retrieve a full history of the stakeholder relationship and associated activities. Suppliers are

incentivised to maintain quality certificates in order to potentially increase and establish relationships with other upstream activity players. For example, if ingredients do not meet quality standards, the regulated entity could revoke the quality certificate and notify everyone in the network who has a relationship directly or indirectly with that supplier. Receiving real-time updates on food quality ingredients enables upstream players to make better sourcing and purchasing decisions and reduces the risk of reputational damage as there is more visibility of downstream activities.

Endorsements could be provided by anyone who has direct contact with the food ingredient. For example, a wholesaler,

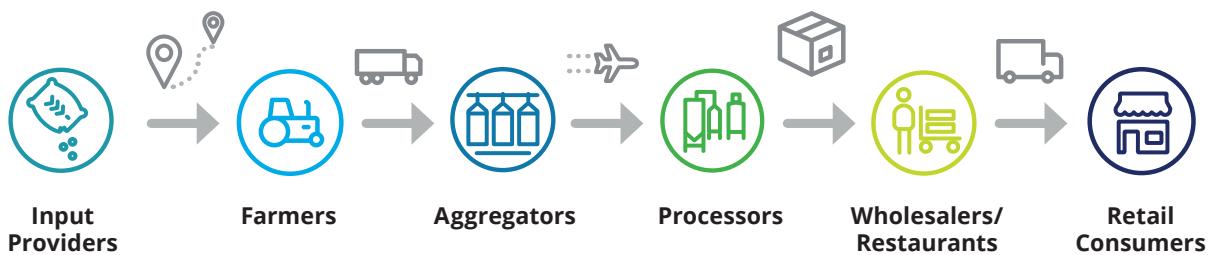
restaurant or even the end consumer could provide a review or rating through the use of an application, effectively creating a transparent review platform for the ecosystem. This would be the first platform to enable all supply chain stakeholders to interact with one another directly and share reviews to better improve the food experience for all. As restaurants become more technologically savvy, the incorporation of such applications into their service offerings would impact their consumer base. Food critics' reviews and ratings could be incorporated into the solution to provide the end consumer with a 360 degree view of the food they are eating.



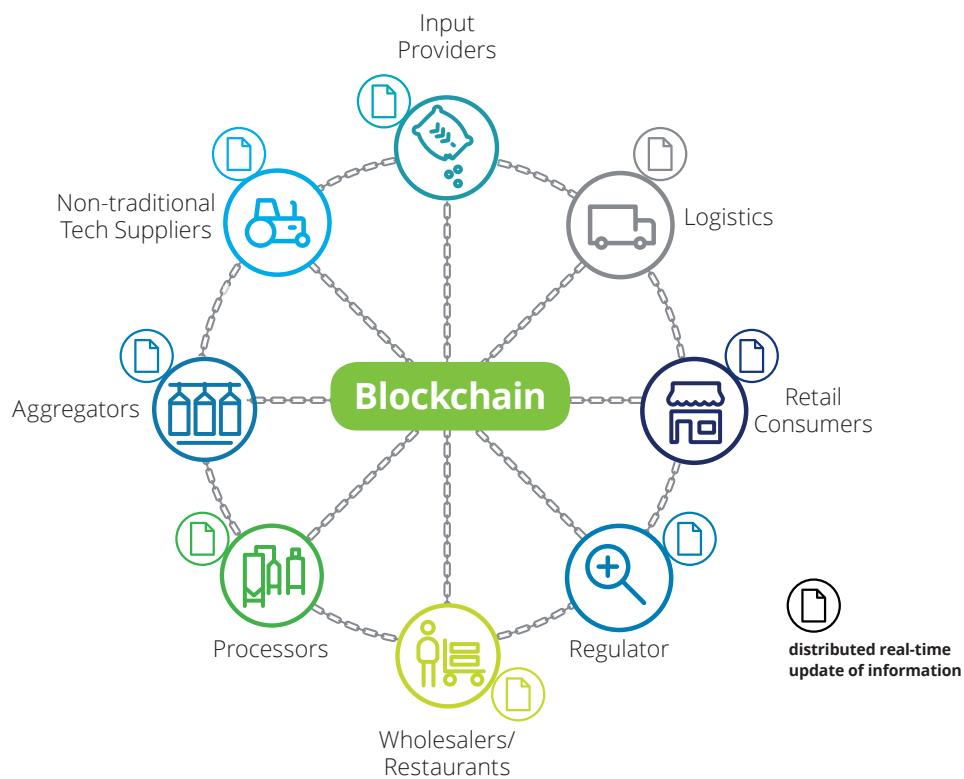


Food supply chain

Today



Tomorrow



Blockchain considerations and challenges

It is critical that organisations conduct a comprehensive review and assessment to ensure they can introduce controls to mitigate and manage the issues associated with blockchain implementation. Careful evaluation of risks using Deloitte's Blockchain Readiness Framework can set the foundations of a prosperous blockchain journey. An organisation's appetite for the risks associated with blockchain may be measured across three primary domains: Standard Risk, Value Transfer Risk, and Smart Contract Risk. Additionally, matters such as levels of market adoption and regulatory involvement raise concerns across most nascent technologies.

Increased transparency, an inherent capability and the most notable advantage of blockchain, may cause some businesses to think twice before progressing towards implementation due to concerns about competitive advantage and security. However, the most common concerns, detailed below, may be mitigated by effective planning.

Source visibility

- Concern:** Competitors might be able to view supply chain sourcing details.
- Mitigation:** The identities of parties involved in a transaction or movement of goods are hidden. Only their public keys are visible to the rest of the network. New public keys can be used for each transaction for added security.

Supply chain security

- Concern:** Using distributed ledger technology might put supply chains at risk of a cyber-attack.
- Mitigation:** Blockchain's underlying capabilities provide data confidentiality, integrity and availability, but as with any other technology, organisations need to have in place robust cyber defence strategies.

Data ownership

- Concern:** A third party might own the supply chain data.
- Mitigation:** Suppliers would need to be incentivised to share data and use the blockchain in conjunction with their internal local data system.

Transaction volume

- Concern:** Competitors might be able to determine how much merchandise is moving.
- Mitigation:** The contents of a tracking record on the blockchain can be encrypted.

Implementing an emerging technology invariably causes businesses to hesitate. However, thorough evaluation of the aforementioned considerations will likely alleviate the risks associated with a blockchain implementation. Above all other considerations, creating a blockchain strategy today will support entities in managing and developing solutions, which can then be shared across the business, remediating existing challenges and creating operational efficiency gains.

How to take action

Launching a blockchain journey may be simplified by planning the approach in the incremental steps shown below:

How to take action



Internal Socialisation

Begin the discussion now in order to gauge business and IT interest in the potential applicability of blockchain within your business



Education

Having secured internal buy-in for the potential use of blockchain, invest in establishing a working knowledge of the technology (what it is, associated benefits, different types, etc.)



Ideation

Team with experts to determine the art of the possible for blockchain as it relates to your business, including the creation of a blockchain strategy and prioritisation of use cases



Use Case Design

Select the targeted use case and define the supporting architecture and Minimum Viable Ecosystem (note that it is often advantageous to start small as it allows for a quick win and demonstration of blockchain's potential)



Implementation

Rapidly progress the prioritised use case through iterative cycles, establishing a go-to-market approach, business case and method to create a commercial-scale product

Blockchain's capabilities in supply chain management is an increasingly popular topic, with proofs-of-concept being developed across all industries. Early entrants have the opportunity to team with regulatory parties and founding providers

and to shape how blockchain technology will function in their industry. With challenges and risks clearly defined and evaluated, the final consideration is whether your business is ready to explore the new frontier of blockchain technology.

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