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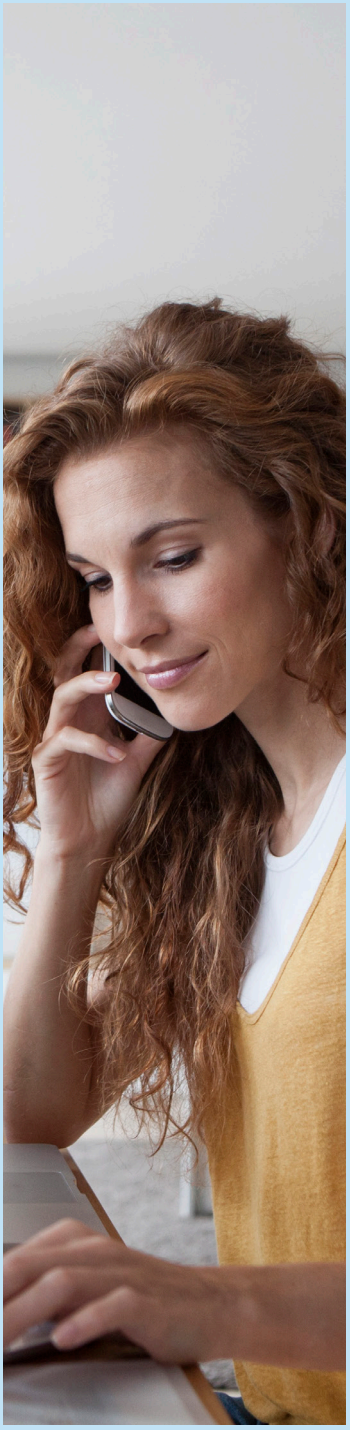

APPLICATION OF BLOCKCHAIN TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT

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Introduction

Blockchain as a technology has been enabling several disruptive innovations in the past few years across a gamut of businesses, most remarkably in the financial services sector. Its application in other industries and the associated business processes is currently at a nascent stage. Supply Chain and Logistics is seen as the next and most significant avenue for Blockchain related processes and technology innovations. This thought paper explores the application of Blockchain technology in resolving some of the biggest and ubiquitous issues of a supply chain process, which majorly arise because of the multi stakeholder architecture.

This paper starts with a brief coverage of some of the essential features of Blockchain Technology. Next, the paper deep dives into various important present-day problem areas of Supply Chain Management and how Blockchain technology can help in resolving these specific issues and thereby, enhance

the efficiency of the supply chain and the overall customer experience. All such applications are explained by real-life use cases from across supply chain. Furthermore, it details the limitations of use of Blockchain technology in Supply Chain Management.

The paper also briefly touches upon the benefits of Blockchain from the perspective of major supply chain processes. We conclude the paper by presenting a view of how Blockchain technology can be utilized in the future in context of supply chain management process.

Since this thought paper explores Blockchain Technology from the lens of supply chain management it limits its emphasis on Blockchain purely as a technology and focusses more on its application Also, this paper does not limit itself to any specific industry or domain. It provides a broad based understanding and presents the reader with a possibility to explore a specific topic of interest in further detail.

Blockchain Technology in the context of Supply Chain Management

In any typical supply chain network, there are numerous transactions performed everyday involving multiple stakeholders. Each of these transactions manifest in the form of material, money and information being exchanged among various parties. Each party of the supply chain network maintains its version of these transactional information in its information systems. These disparate systems and limited trust among the stakeholders of a supply chain, lead to many inefficiencies and disputes thus reducing the efficiency of the complete value chain.

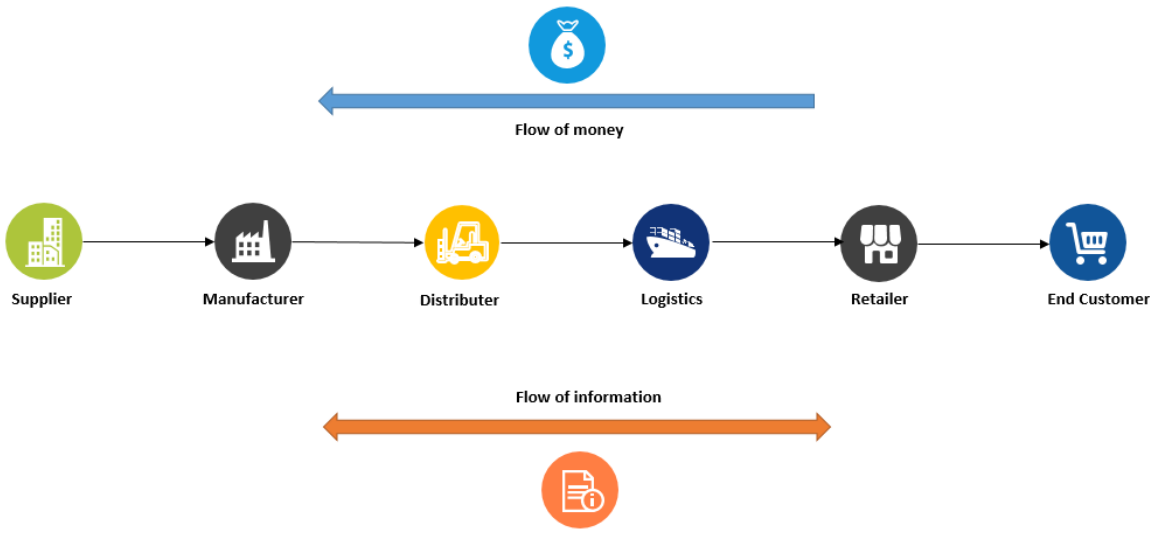

Figure 1: Illustration of a simplified supply chain

Blockchain is a distributed ledger technology, which can help in creating a reliable, shared and tamper free record of all such multilateral transactions. Meaning, each of the party involved in any transaction will have an identical copy of the same record in their own information system. In a blockchain, all such transactions are committed only after the consensus of all the parties involved. Once a transaction is recorded, it cannot be updated or deleted by any single party. This vastly reduces the chances of error or tampering. Thus, substantially increasing the trust and efficiency throughout the supply chain network.

A more technical definition of blockchain technology will be a decentralized ledger system that is cryptographically secure, tamper free and append only which allows updates only by an established consensus mechanism.

Decoding Blockchain Technology

A blockchain is nothing but a linear set of blocks. These blocks keep being added with each new transaction or an update in a supply chain process. Let us take the example of a simplified Supplychain for passport manufacturing and personalization.

The manufacturing of a passport booklet is quite unlike a regular paper booklet manufacturing. Besides the regular processes like sourcing of paper and thread, binding of booklet and personalization, there are a multitude of security features embedded at each step. For example - The paper can have an anti-scan pattern, a watermark, and invisible fluorescent fibers while the thread and cover used for binding the passport booklet can have certain information encoded in it. In fact, the personalization process involves printing of the passport with a special ink and in many cases, a chip is also embedded. The government of a country, depending on the security guidelines for passport design, chooses specific vendors for each sub process.

The passport supply chain starts with sourcing of security feature laden papers and special thread for the manufacturing of blank passport booklets. Post sourcing these papers, a government designated high-tech supplier will manufacture the blank booklets and ship it to the designated personalization vendor. Once the government passport department receives a request for a new passport, it will send a personalization request to the designated vendor, who will then print the details of the citizen onto the passport booklets. Usually a chip containing the personal details is embedded as well. A different supplier can do this as well. Once embedded with the chip, printed and quality checked, the passports will be sent directly to the applicant.

The below figure illustrates how these set of transactions will be created in a blockchain.

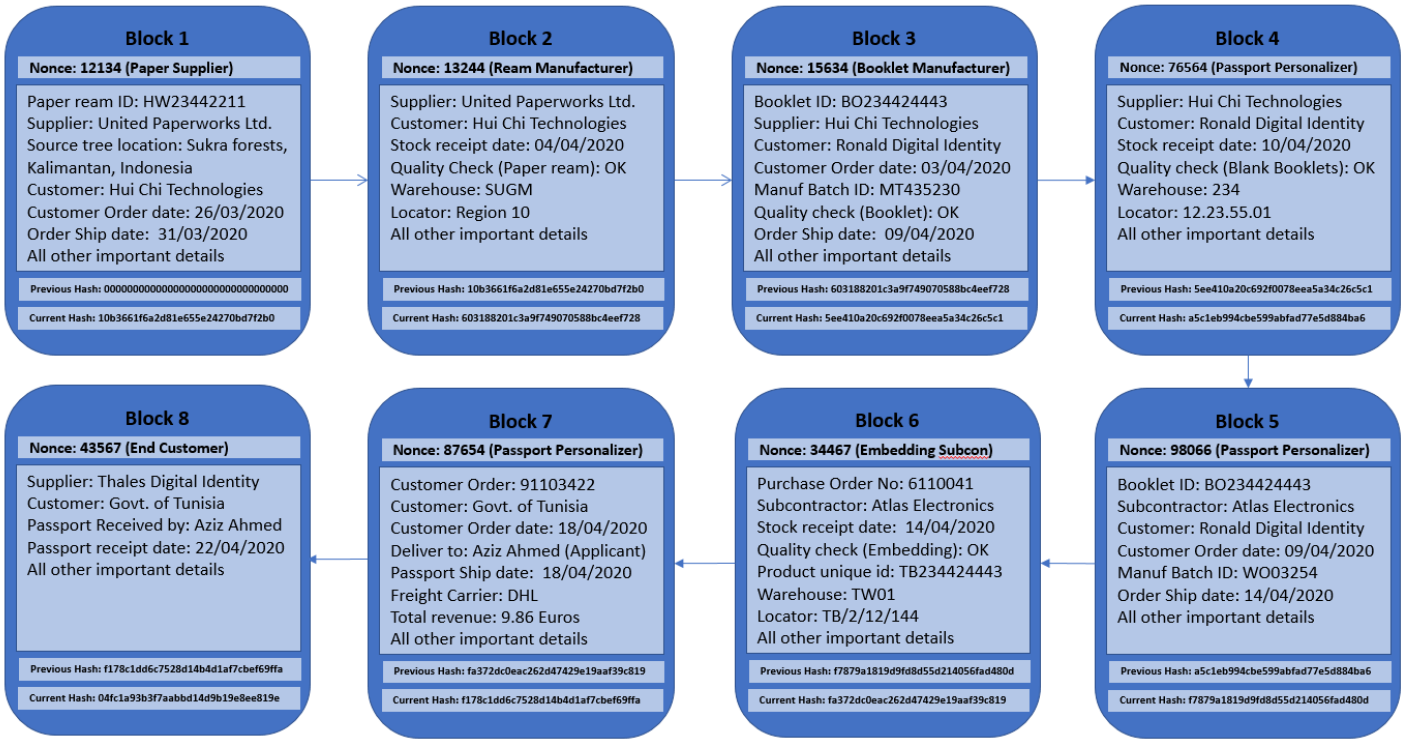

Figure 2: Blockchain representation of a passport supply chain

Tokenization: Any asset being transacted in a supply chain will be a physical good or a service. These assets need to be represented digitally in a blockchain. Thus, a token represents a digitalized asset. In the above example, various physical goods from a paper ream to the printed passport are tokenized in the blockchain.

Cryptographic techniques in Blockchain: For ensuring data security, blockchain utilizes public key cryptography or asymmetric cryptography. Consequently, any entity having a public key can append information to the blockchain while only those parties that have the private key will be able to access and read the information. Typically, blockchains utilize hash algorithms to encrypt the messages. In the example above, we have used SHA-256 algorithm to encrypt the information, which provides a 32-bit alphanumeric encrypted code for a message of any length.

Immutability: Any information once written in a blockchain cannot be changed. In fact, an update can only be performed in the form of a new block added to the blockchain mentioning which of the earlier blocks needs correction and the specific correction required. The immutability feature in a blockchain is maintained based by the hash code of each block. Hash codes are the encrypted alphanumeric codes which contain not only the data of the current block but also the hash code of the previous block. Hence, if someone makes a change in any data of one of the blocks, the hash codes of all preceding blocks are updated and this alerts the stakeholders about the data security breach and the blockchain is restored to normal again.

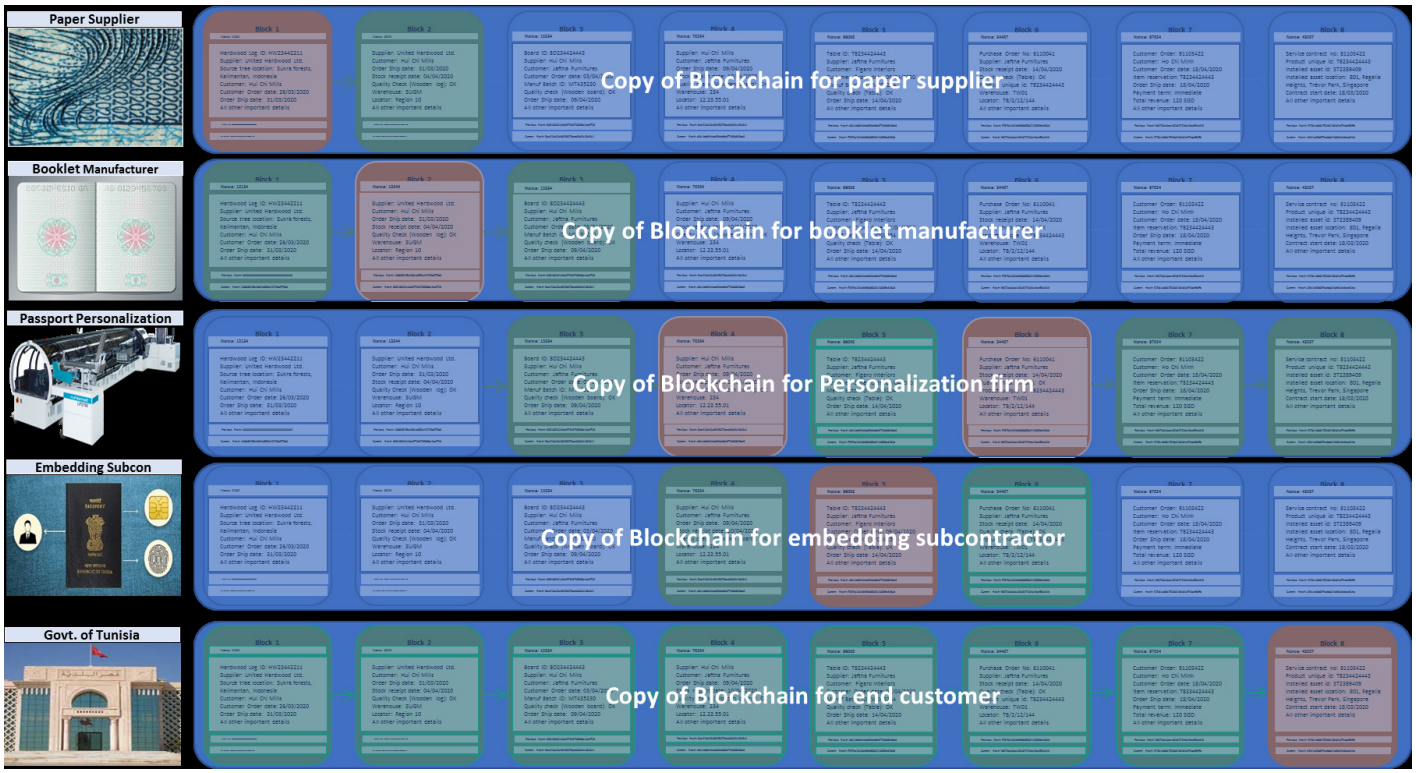

Figure 3: Illustration of network nodes and distributed ledger system for various stakeholders. Blue blocks represent non-accessible information, green blocks signify read access while red blocks indicate read and write access. Each set of nodes correspond to the detailed nodes illustrated in Figure 2.

Network Nodes: Nodes represent the stakeholders in a supply chain. In the above case, the booklet manufacturer or personalization vendor correspond to a node. Depending on the system architecture and permissions provided to different nodes, they may be able to read/write information on the blockchain. Also, the parties involved in a transaction will have the provision of approving or validating a transaction. In above example of passport supply chain, the end customer i.e. the government needs

to keep complete control on every aspect of the process. Blockchain allows access to limited information by different stakeholders while allowing them to contribute to or read the information that is relevant for them. The red (write, read), green (read only) and blue (no access) blocks signify different levels of access each stakeholder has in this blockchain.

Consensus Mechanism: In a distributed ledger system, no single party owns the ledger and hence the authority of approving any new record is distributed. Therefore, all the parties, which are involved in a transaction, will need to validate and approve any addition to the blockchain. This ensures the ledger remains reliable for all parties. In the above example, high security paper supplier and the booklet manufacturer are involved in a transaction. Consequently, both the parties will need to confirm the information in Block 1 and Block 2 before this information is permanently written in the blockchain.

Distributed Ledger: A system of transactions which is synchronized and is accessible across stakeholders and geographies. This is in contrast with a centralized ledger where each party maintains its own ledger. Cyber-attacks and financial frauds can come down substantially when distributed ledger are used in context of Blockchain. The immutability and consensus mechanism ensures no illegitimate updates are made to the ledger. The underlying technology of bitcoins is distributed ledgers which has disrupted the currency markets over the past decade.

Longstanding issues in Supply Chain Management - Blockchain to the rescue

Many of the painful and perennial problems of supply chain networks arise out of its very design i.e. a web of transactions between multiple parties each competing for a larger slice of 'the margin pie'. Blockchains, on the other hand, are inherently designed to simplify such multi-stakeholder interactions.

Trust deficit in a multi-stakeholder scenario: Limited information sharing, each party managing transactional data in isolation and probability of tampering the information of value for one's own benefit are some of the reasons for existing mistrust amongst different stakeholders in a supply chain. In most cases, tampering or forging the information will increase margins for one of the stakeholders at the cost of value delivered to the customer.

The Blockchain, by virtue of being an immutable and decentralized system, which is updatable only by consensus, can drastically reduce the trust deficit and avenues for tampering. For example, given the volatility of the crude oil prices, a supplier can tamper with the shipment date and time. This will increase the supplier's margin at the cost of refiner's margins. If all these stakeholders are knit into a blockchain, then the shipment date and time will be as per the crude oil barrel scanning performed by the freight forwarder. Thus, bringing fairness, trust and single source of truth for all parties.

Product provenance and traceability: Is the expensive wine really from Saint Emilion's vineyards of Bordeaux as it claims to be? Is the honey on the shelf of a gourmet food shop organic? Blockchains can help in digitizing the footprint of a product in cases where its origin commands value. Immutability of records and consensus in updates ensure that someone does not alter the product trace or provenance for their own benefit or stake at a later stage.

In this context, the world's largest diamond producer, De Beers has already completed the pilot of a blockchain project to trace the lifecycle of diamond from the mine to cutter and polisher and finally to jeweler. Each diamond that is mined is uploaded with its picture and attributes like color, quality and location to the blockchain. Similarly, the complete journey until the jeweler showroom is captured in the blockchain, which is then made accessible to the customer. This not only provides satisfaction to the customer but also provides a way for all the stakeholders of the diamond supply chain to track high value commodities across its lifecycle.

Product authenticity: Counterfeits and imitations are perpetual problems of industries with heavy investments in R&D and IP asset creation. Supply and distribution of such products will continue given the disproportionate margins and windfall gains these products ensure. In fact, the pharmaceutical market has counterfeit medicine sales in the range of $163 – 217 billion per year as per PWC report (Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, 2017). To ensure the quality of the drug meets the regulatory standards, Governments of matured markets are moving towards enforcing unit level tracking and tracing of pharmaceutical production by law.

The supply chain of pharmaceutical industry involves plethora of parties. Be it, certification from the drug controlling authority, trials by independent sampling and test laboratories or the usual stakeholders of manufacturing and distribution process. Blockchain technology could help in maintaining the traceability of each unit and also make the validation and certification process more secure and failsafe. A real-life example is that of GSK which is working with Viant technologies to bring in multiple stakeholders of its supply chain within the ambit of a single blockchain.

For the pharma giant, this means better compliance, driving cost efficiencies and enhancing customer experience at the same time.

Data duplicity and redundancy: Each stakeholder maintaining an isolated ERP requires its own copy of the transaction. This requires substantial manual updates on disparate systems and is prone to errors as well. Automated interfaces from an over-arching block chain system can take care of simultaneous updating and progression of the workflows of these multiple ERP systems involved in a transaction. For example, the receipt of goods at customer location can trigger three updates to three different systems:

1. Receipt against the PO at customer location.
2. Closing of delivery lines on Freight forwarder's system.
3. Closing of SO line for the supplier.

Smart Contracts: Rule based, pre-programmed contracts which can be automatically executed based on certain triggers or events are called smart contracts. In the context of Blockchain, the code of such smart contracts are embedded in a Blockchain. This makes such contracts tamper-proof and any update requires to follow the principle of stakeholder consensus for any updates. Thus, in a multi-stakeholder scenario, transfer of payments, termination of contract, etc. can be triggered based on the events registered on the Blockchain, limiting the role of third party for escrow transactions or intermediaries because of trust deficit amongst the parties. Most of the supply chains around the world are still rely on paper documentations, validations and physical transfers for releasing transactional payments. For e.g. Bill of lading needs to be signed by the shipper, carrier and receiver which allows for financial settlement between the parties. Smart contracts can make the process paperless, swift and simplified for all stakeholders.

Is Blockchain the Panacea?

Blockchain is not a cure-all solution to all supply chain problems. There are limitations to what blockchains can achieve.

Immutability: While this is a valuable feature of blockchain architecture, in a supply chain, there are corrections required due to data issues or manual errors. While introducing IOT devices and automation of transactions can substantially reduce these errors but corrections and updates will remain part of daily supply chain activities. In a blockchain, any changes can only be made in the form of a new block, in effect, an amendment.

Process and data synchronization: For all stakeholders to have a single truth it is a prerequisite to have the business processes, unit of measures and master data synchronized among the disparate information systems. This will require considerable changes in process and systems. This can substantially increase the blockchain deployment costs, which might prove a deterrent to organizations adopting it.

Data protection and privacy: The widespread accessibility to the 'single source of truth', as delivered by Blockchain, comes with its own downside. Public blockchains are accessible by anyone and the blockchain copies are distributed globally. This public accessibility of commercial information might not be best suited for most of the organizations. Alternatively, firms can choose to have a private blockchains. These are more secure and provide the access to the data to stakeholders. It also implies that private or hybrid blockchains have a much higher implementation and maintenance cost.

Benefits of implementing Blockchain

The benefits of Blockchain technology from the perspective of data security and its applications in trade finance sector are quite well known. Here we will try and decode the promise that Blockchain holds for some of the major supply chain processes.

Source to Pay: Delayed payments and endless follow-ups for outstanding payables from the customers have been a norm for a very long time. Blockchains can end this cycle by integrating deliveries and payments using smart contracts. Consensus mechanism will ensure that the agreements on all pre-requisites of payments are well recorded in the blockchain. Thus, allowing swift payments to suppliers and also reducing the costs of audit and control.

Order to Cash: Then end customer experience is waiting to undergo a big change with the use of Blockchains in customer ordering process. In Industries where the final product derives its value based on provenance or sourcing of raw material, blockchain is expected to revolutionize the customer experience. Customers will have the opportunity to validate the details of sourcing of the product they intend to buy. Examples include food and wellness industries. Players who make use of Blockchains and provide the options of validating the product provenance or authenticity will be at a competitive advantage.

Demand and Supply Planning: The distributed ledger which is constantly refreshed incorporating information from all the relevant partners whether internal or external will enable the planners to see the total volumes across sales, purchase and manufacturing channels. Currently, planners and the forecasting teams spend substantial amount of time in collecting such data and consolidating into the demand forecasting and supply planning system. This will bring down the inventory cost and incidences of stock outs substantially.

Inventory Management: Distributed ledger, smart contracts and consensus mechanism hold the promise of improving the stock accuracy as any issue or receipt transaction will be validated by multiple stakeholders before being added to the blockchain. This will reduce the need for daily or weekly physical stock counting exercise, thus saving on logistics FTE and also helping in better planning of restocking activities. For the customer/ vendor owned stock, it will mean continuous and perpetual visibility of the consigned stock.

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Conclusion

Blockchain's application in Supply Chain Management process is in its infancies as of now. Even in industries like processed food and pharmaceuticals, the full extent of benefits are yet to be realized. Early use cases have shown significant improvement in product provenance, authenticity validation and reduction of audit & dispute costs. In medium term, blockchains are deemed to become a standard offering in cloud ERP and supply chain applications. Early adopters of the technology tend to be large, complex organizations with vast intercompany and trading network. These organizations will develop their own ecosystems of blockchain and persuade their supply chain partners to adopt these systems. While small and mid-sized supply chain participants will depend on cloud based blockchain solutions which have lower infrastructural costs and are easier to integrate with legacy systems.

As the market and technology matures, we'll start to see blockchain enabling distributed, autonomous marketplaces, making transactions virtually paperless and frictionless. Also, as distributed ledger gains trust and momentum, it's bound to reduce the payment cycles and bring down the proportion of transactions that move to dispute resolution thus freeing up working capital and reducing cost of capital. In essence, we are only witnessing the tip of the iceberg as far as application of Blockchain in supply chain processes is concerned.

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Nishant is a business consultant with Infosys Consulting and has experience in leading Digital and ERP transformations in Hi-Tech Manufacturing and retail industry. He's a Procurement and Order Fulfillment process specialist and has helped clients to improve their profitability and reduce costs through process redesign, process improvements and ERP harmonization. Nishant is passionate about identifying and exploiting AI, ML and RPA automation opportunities across business processes.

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