

Blockchain for Supply Chain Management: Opportunities, Technologies, and Applications

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INTRODUCTION

Over the past decades, digital technologies empowered more efficient, effective and connected supply chains. Many organizations have invested a significant amount of resources in various supply chain management (SCM) in order to improve performance and profitability. However, as supply chain complexity continues to increase, organizations face new challenges of maintaining visibility into origin, authenticity, and asset handling as they cross organizational boundaries (Stefanovic, 2015). The existing SCM information systems and apps usually cannot provide required visibility, traceability, automation, provenance, and efficiency.

Blockchain technology is considered to be a game-changer for decentralizing infrastructure and building a trust layer for business logic. It is envisioned to be a technology that could drive us into the next industrial revolution, with new paradigms for doing business in supply chain, transportation, manufacturing, finance and many other industries (Vorabutra, 2016).

It has a potential impact on most documentation processes, but it adds value through the ability to track purchase orders, assign and verify certifications, link physical goods to IoT (Internet of Things)-enabled devices, such as digital tax, barcodes, and serial numbers, and sharing such information with suppliers, vendors, and other supply chain partners (Robinson, 2019).

Blockchain is a transparent and verifiable system that will change the way supply chain partners exchange value and assets, manage contracts, and share data. The technology is a shared, secure ledger of transactions distributed among a network of computers, rather than resting with a single provider. Blockchain can be used as a common data layer to enable a new class of SCM applications. Thus, business processes and data can be shared across multiple organizations, which eliminates waste, reduces the risk of fraud, and creates new revenue streams.

Blockchain-based supply chain solutions are changing the way industries do business by offering end-to-end decentralized processes via the distributed and digital public ledger (Miaoulis, 2019).

Blockchain within the supply chain provides supply chain participants with a decentralized ledger that can store an entire history of transactions across a shared database — an ideal solution for multi-tier collaboration within the context of a dynamic and digital supply chain ecosystem (Doubleday, 2019).

Certain supply chains are already using the blockchain technology, and literature suggests blockchain could soon become a universal “supply chain operating system” (Spend Matters, 2015). Blockchain technology could improve the following supply chain tasks:

- Recording the quantity and transfer of assets - like pallets, trailers, containers, etc. - as they move between supply chain nodes (Gonzalez, 2016)

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- Tracking purchase orders, change orders, receipts, shipment notifications, or other trade-related documents
- Assigning or verifying certifications or certain properties of physical products; for example, determining if a food product is organic or fair trade (Herzberg, 2015)
- Linking physical goods to serial numbers, bar codes, digital tags like RFID, etc.
- Sharing information about manufacturing process, assembly, delivery, and maintenance of products with suppliers and vendors

Supply chain organizations must can achieve significant benefits from blockchain in core areas of supply chain operations (Francis, 2018):

- Removing paperwork - by using blockchain to create a tamper-proof “master ledgers” between trading parties
- Creating “smart contracts” - that check when new records are written, ensure there are no out of balance conditions, and remove the existence of ‘bad’ invoices
- Having a single system of record - replicated across all partners to a transaction, which enables the impartial enforcement of contract terms

With the power to bring transparency and accountability to even the most complex supply chains, blockchain is poised to transform the way suppliers, retailers, and consumers interact with one another and their goods. Blockchain has the potential to replace complicated, error prone processes such as look-back auditing with streamlined smart contracts. As the technology grows and matures, it will be used to open new doors for cross-organizational collaboration and enable new business models along the supply chain (Microsoft, 2018).

Supply chain blockchain is taking ground at a rapid pace. Most of the key technological components needed to create robust supply chain blockchain networks are available or in a mature development stage. However, radical change will truly start to take shape through the integration of blockchain with other innovative technologies like AI and IoE (XChain2, 2018).

In this chapter, we discuss the various opportunities blockchain provides for SCM, as well as the main technologies including infrastructure and services. The main applications and benefits of blockchain for SCM are described including smart contracts, payments, transaction recording, dispute resolution, environmental monitoring, and security. We also introduce the multi-layered and cloud-based hybrid blockchain model that combines various data, integration, blockchain, and security services.

BACKGROUND

Supply chains are definitely critical for the overall success of today’s organizations. Supply chain management includes integrated planning as well as the execution of different processes within the supply chain such as planning, sourcing, making, delivering, end returning. These processes include material, information and financial flows (Stefanovic & Stefanovic, 2013).

Supply chains are currently managed on centralized software platforms, and the chain activities rely on human paper-and-pen processes to ensure certified products are delivered as intended to final consumers. The current supply chain management system as it exists today is outdated and unable to

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