Synopsis: A Digital Global Supply Chain

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Recommended Citation
Available at: https://scholarsarchive.byu.edu/marriottstudentreview/vol2/iss2/15

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Cover Page Footnote
This is a synopsis of the full article in this issue.

This article is available in Marriott Student Review: https://scholarsarchive.byu.edu/marriottstudentreview/vol2/iss2/15
The Digital Global Supply Chain: The Growing Case for Blockchain Technology Expansion Within Global Supply Chain

By Jonathan Chichoni

Note from the editor: The following article was adapted from an honors thesis of the same name written by the author. The full text is available on the ScholarsArchive website. Also, for further background explanations on blockchain data storage technology, the reader is directed to “A Bit about Blockchain,” located in this issue of MSR, or “Strategic Implications of Blockchain” from MSR Vol. 2 Issue 1.

The Digital Global Supply Chain: The Growing Case for Blockchain Technology Expansion Within Global Supply Chain

By Jonathan Chichoni

Case Study Analyses

These four case studies were selected on the basis of showcasing the supply chain benefits of adopting blockchain that were of the greatest importance to each company and may slightly vary from the total importance scores for the industries in which they operate. We see this particularly with Walmart as well as in the study of time savings as a blockchain benefit to Maersk. Each of the seven supply chain benefits of blockchain adoption are represented in these case study analyses.

Walmart – Traceability in the Food Supply Chain

Traceability along the supply chain is essential in determining where and when bottlenecks, compliance issues and quality issues arise. Increased traceability of goods along the supply chain leads to more efficient planning, greater consumer trust and higher quality products. Blockchain creates an immutable chain of custody for food goods from origin to destination.

Walmart Case Study Backdrop

Every year, 1 in 10 individuals get sick because of foodborne illnesses globally. It is estimated that roughly 420,000 of those individuals affected by foodborne illness die each year (World Health Organization 2017). In addition to these unit statistics, consumers have become more conscious of foodborne illnesses in what they buy. With the advent of smart technology, the average consumer is now more adept at researching and reviewing the food products they choose to purchase. Regulators have made a larger conscious effort to introduce greater food safety protocols and procedures to protect consumers from fraud and foodborne illnesses. In 2011, the FDA introduced the Food Safety Modernization Act (FSMA) with the purpose of forcing food companies to place a greater emphasis on foodborne illness prevention as opposed to foodborne illness containment. The new statute made it so that companies must be able to continuously track their food products along the supply chain or they will face regulatory imposed damages (U.S. FDA 2011).

In 2013, Foster Farms issued a recall on all Foster Farms chicken products in an effort to contain a suspected outbreak of salmonella that is estimated to have infected some 634 individuals. In 2015, Chipotle suffered from an E. coli outbreak that afflicted over 55 people. The results were devastating to their brand and to their market capitalization. Both Foster Farms and Chipotle still cannot to this day pin down the exact source of the food illness outbreaks that were reported as a result of their food products. Other brands such as Dole Foods, Taco Bell, and Pilgrim’s Pride also suffered from a lack of traceability in their food supply chains resulting in foodborne illness epidemics in the U.S. Against this backdrop, Walmart and IBM created a partnership to implement blockchain as a solution to these issues.

How Walmart’s Blockchain Functions in Food Supply Chains

In the latter half of 2016, Walmart created a partnership with IBM to use blockchain in Walmart’s supply chain. The project began as a pilot to track and trace the origin of pork products in China and produce in the U.S. (IBM 2017). In August of 2017, after a year of successful results with their pilot program with blockchain, IBM and Walmart announced a partnership with Tsinghua University in China to investigate further uses of blockchain in their Chinese and U.S. operations. The partnership announced in 2017 tracked pork, mangoes and other food items.
Blockchain Benefits Applied to Global Supply Chains

Companies worldwide can benefit from adopting business blockchain networks into their global supply chains. The benefits of blockchain that will be analyzed in this case study are the following:

1. Time savings:
   Transaction times for multi-faceted and multi-party supply chains can be cut significantly. The de-centralized nature of a blockchain network allows this to happen. Supply chain's lead times can be cut even shorter and lag times can decrease also.

2. Security improvements:
   The distributed ledger technology component of blockchain protects against tampering, cybercrime, fraudulent products and hacking. This occurs through the permissioned cryptographic technology that can identify all network participants in the blockchain. The consensus features – proof of stake, multi-signature, practical byzantine fault tolerance and smart contracts – protect supply chains and all participants from counterfeit records, fraudulent goods and hacking attempts.

3. Auditability:
   Regulators and trusted 3rd party auditors can more efficiently and more easily monitor a single ledger that records all transfers of asset ownership and transactions. As supply chains extend across borders, jurisdictions and modes of transportation, the relevant supply chain parties in the network can audit the necessary documentation to move supplies in real time and in an automated format.

4. Enhanced levels of trust and transparency:
   Each network participant can determine which details of which transactions are visible to the other network participants. Permission can be granted to regulatory authorities and to trusted 3rd party auditors to view ownership transfer and transaction information in greater detail. Supply chains can keep relevant internal data to themselves while also offering distributors and suppliers certain informational details, and the transparency required to streamline the process of shipment, information, documentation and cash management.

5. Enhanced operational efficiency:
   By digitizing the ownership of assets and the use of smart contracts, transactions and transfer of ownership can occur at a greater speed with fewer lead times and fewer bottlenecks. Supply chains can optimize and streamline all the necessary flow of information, money and goods at speeds without slowing down the supply chain.

6. Potential for cost savings:
   Due to reduced oversight constraints, fewer intermediaries, and less duplication of effort across the blockchain network, costs can be reduced significantly.

7. Traceability:
   Blockchain seamlessly tracks assets on a single line (blockchain) from origin to end destination. This provides a benefit along the end to end supply chain in identifying sourcing groups, the assets themselves, and those involved along the supply chain. The chain of custody of assets is tamper resistant, giving the network participants the ability to trace assets origins and destinations. Supply chains can monitor, track and trace goods as they move from point of origin to point of delivery.

Diagram that illustrates the applications of blockchain across a food supply chain like Walmart.

New Developments

In December of 2017, Walmart and IBM expanded the partnership to include JD.com, Unilever, Dole, Nestlé and other food giants. This consortium of companies widened the scope of their partnership to use blockchain to integrate their online and offline traceability for food safety and quality management channels. Each company that joins the partnership in the future will be able to choose the traceability solution that best fits their needs and systems. All partners will benefit from the exchange of information and from the secure data transparency that blockchain provides.

Operational efficiency, time savings, and cost savings in global trade are three of the central pillars upon which firms like Maersk compete.

In response to regulatory and consumer pressures, Walmart has created a consumer viewable supply chain solution available across 400 of its stores in mainland China. Using the distributed ledger technology of blockchain, Walmart has built an additional application where consumers can scan quick-response codes on food products with their smart phones that will show them the origin and supply chain of the food products they are purchasing in real time. The data for the partnership is stored on a unified storage platform powered by blockchain and has decreased the time it takes to trace the origin of food products from weeks down to two seconds. The published results of this partnership are greater traceability, transparency, time savings in discovering origins of products and potential hazards, greater satisfaction for end consumers and safer food.

Walmart established a blockchain platform to manage their supplier relationships that tracks and traces the quality of food products along the supply chain. Every supplier in the chain uses a unique digital identity permissioned by Walmart to access and participate in the platform. The smart contracts consensus feature of blockchain allows each supplier, wholesaler and distributor to store the data associated with the quality and trajectory of the food goods in the supply chain. In this framework, Walmart and the other participants mandate that their pre-approved quality certifications (expiration data, date of testing, color, etc.) must be approved by the necessary regulators and individuals along the supply chain. Each member along the supply chain would then endorse the food products as they move along the supply chain until they arrive to the consumer. The consumer can then use their smartphone to scan the quick-response codes provided by Walmart, giving them a complete view of the food’s journey along the supply chain. Below is a

Figure 1-3 (Source: Deloitte)

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need for multiple parties to approve and produce the required documentation across shipping routes.

**Maersk Case Study Backdrop**

According to the World Economic Forum, more than $4 trillion in goods are shipped every year, and over 80% of the goods used by consumers daily are carried by the ocean shipping industry. Maersk accounts for 15.8% of the world’s shipping fleet traffic and for the years 2014-2016 experienced a sharp decrease in annual revenues (Figure 1-7). Published in their annual report were rising costs associated with trade documentation and administration. According to Maersk, the costs associated with trade documentation and administration of those goods are estimated to be one-fifth of the actual physical transportation costs. Maersk conducted a study in 2014 that revealed that on average there are 30 people or organizations involved in the shipment of a single container. This results in over 200 separate transactions, with each transaction requiring a new set of documents. The shipping industry as a whole is slowed by communication across transportation providers, freight forwarders, regulators, governments, ports, customs brokers and ocean carriers (Lieber 2017). Couple this challenge with a global decrease in shipping volumes for the years 2014-2016 and adopting blockchain begins to make sense.

In addition, the World Economic Forum also projects that by reducing barriers in the international supply chain system, global trade could increase by nearly 15%, which could theoretically boost employment and stimulate growth in economies worldwide (Maersk 2017).

**How Maersk’s Blockchain Functions in Global Shipping and Trade Supply Chains**

In June of 2016, Maersk and IBM began a partnership to incorporate blockchain technology into Maersk’s complex global supply chain. After a year and a half of successful development and piloting, Maersk and IBM announced an official joint venture to provide more efficient and secure methods of conducting global trade. The joint venture is its own entity that is separate from Maersk and IBM but co-owned and distributed by both companies. This joint venture was organized to create a digitized global trade platform built on open standards that can be used by all participants in the global shipping ecosystem including port authorities, customs organizations, logistics providers and governments.

Maersk and IBM’s blockchain framework takes specific advantage of blockchain’s open-source fabric application. Maersk and the organized consortium of other participants in the shipping industry use blockchain to cut down on documentation costs through the use of blockchain’s distributed ledger technology. Each participant’s transfer of ownership of goods is recorded in a permanent, inalterable ledger that all can view. Through the use of smart contracts, participants have experienced streamlined documentation without the need for gaps and lead times to draft new documentation or wait on lengthy approvals. This increase in efficiency has cut both documentation and 3rd party costs while also streamlining shipments. In addition, Maersk noticed a decrease in fraudulent and error-based labeling of containers given that blockchain was able to successfully present the movement of goods in real time to all network participants. The permissioned and consensus functionalities of blockchain have allowed regulators such as the Customs Administration of The Netherlands and the U.S. Department of Customs and Border protections to manage their own nodes in the network and automate the approval and regulatory checkpoints along the shipping supply chain.

Additional customs and government authorities, including Singapore Customs and Peruvian Customs, are exploring the option to collaborate with the platform to facilitate trade flows and enhance supply chain security. The global terminal operators APM Terminals and PSA International will use the platform to enrich port collaboration and improve terminal planning. Maersk has also garnered support from the Guangdong Inspection and Quarantine Bureau by connecting to its Global Quality Traceability System for import and export goods.

Maersk and IBM have also begun to conduct research on empowering their blockchain application to solve “the empty container issue” by giving more parties access to the availability of nearby ships with real time tracking of empty containers. Maersk has also enlisted its own supply chain solutions company Damco, which handles departure points and arrival points, to work with international regulators on their blockchain network in a streamlined and efficient way.

In short, the distributed permissible application of blockchain has enabled Maersk to exchange transfer of ownership data, automate and speed up document workflows, create fraud resistant container tracking and track shipments from beginning to end without costly interactions among all the parties in the supply chain. They have successfully been able to track millions of containers and shipments while interfacing with regulators and other handlers along the way with complete trust. So far, the blockchain pilot test and the joint venture have been successful in increasing operational efficiency, transparency, cost savings and time savings.
Dubai Government – Auditability & Compliance in the Supply Chain

Auditability and compliance simplicity are essential for regulators to do their jobs effectively. With an increase in supply chain complexity, documentation costs, and fraudulent/illegal goods passing through borders, regulators and government agencies are in need of greater auditability and compliance simplification. A careful balance exists between protecting the end consumer and stimulating business and economic growth. This tightrope has been difficult to walk for companies and regulatory bodies alike given challenges in visibility into the operations of the companies they regulate. Blockchain incentivizes both parties by simplifying the compliance system through its automated consensus technology and reduces the need for large amounts of documentation through its distributed ledger technology. Visibility into complex supply chains makes it simple for regulators to audit the flow of goods and documentation along the supply chain through blockchain’s permissioned applications of distributed ledger technology.

Dubai Case Study Backdrop

According to the Organization for Economic Cooperation and Development, counterfeit goods is a $250 billion industry annually. The prevalence of these counterfeit goods is only exacerbated by a lack of transparency within the supply chain. Regulators are increasingly demanding greater transparency within supply chains regarding the composition and origin of products as well as greater visibility into Tier 2+ suppliers. Integrating internal and external data dependencies with complex multi-national regulatory and documentation requirements has also become a challenge in the supply chain environment. Governments and businesses alike are struggling to adjust to the rapid advancement of new product introductions, the evolving nature of the third-party provider landscape and changes in distribution networks.

How Dubai is Using Blockchain for Enhanced Auditability and Compliance Simplification

In February of 2016, Dubai announced the creation of the Global Blockchain Council with a goal to implement every facet of blockchain technology into their city. In May 2016, the council outlined seven proofs of concept for how the city of Dubai could implement blockchain. The first two that they have begun to tackle are:

1. Apply blockchain to trade finance in order to more effectively exchange goods and streamline the financing for those goods.
2. Streamline ID verification to reduce business registration times.

In February of 2018, IBM and Dubai launched a partnership in conjunction with eight organizations across three different countries for tracking the import and export of goods into Dubai. The blockchain components that Dubai has adopted for this supply chain task are blockchain’s distributed ledger fabric to provide supply chain participants and regulators with real-time shipment data and blockchain’s consensus applications, like smart contracts, to simplify the regulation and oversight of shipments in and out of Dubai (Smart Dubai 2016).

Regulators in Dubai will be able to provide the specifications and documentation necessary for trade participants and also be able to automate the completion and submission of the required documentation in real time through the use of smart contracts and the permissioned version of blockchain. They would have visibility into the movement of goods, the submission of documentation and the power to grant or withhold permission to participants on the blockchain. The distributed ledger function allows for government officials to track each movement of trade goods with the security of knowing that unless it passes through a government permissioned participant, the shipment will not enter Dubai.

New Developments

Beyond blockchain’s application to trade finance, The Smart Dubai Council projected that blockchain’s adoption into other governmental spheres beyond simplifying the compliance process and giving greater auditability for trade would include other benefits. They stated: “Required documentation, such as visa applications, bill payments and license renewals, which account for over 100 million documents each year, will be transacted digitally under the new strategy. Blockchain technology would contribute savings of up to 114 Mtons of CO2 emissions from trip reductions and redistribute up to 25.1 million hours of economic productivity in saved document processing time. In adopting blockchain technology, Dubai stands to unlock 5.5 billion dirham in savings annually in document processing alone — equal to one Burj Khalifa’s worth of value every year.” (Smart Dubai 2016)

While the pilot test has revealed few published statistics, government officials remain hopeful regarding the success of blockchain adoption in providing auditability and simplicity in the compliance process.


**Merck – Security in the Pharmaceutical Supply Chain**

Security in the pharmaceutical supply chain is paramount. Given that pharmaceutical companies’ greatest asset is their intellectual property, there exists a great need to ensure that intellectual property from competitors and cyber-attacks. Pharmaceutical companies spend billions each year in research and development with the goal of creating, marketing and distributing their intellectual property in the form of medicines and medical devices. In addition to protecting their research from competition, pharmaceuticals face the daunting task of protecting their brands and the end consumer from counterfeit pharmaceutical product. Through the application of blockchain’s distributed ledger, consensus, cryptographic, and permissioned features, the security of pharmaceutical supply chains can be greatly enhanced.

**Merck Case Study Backdrop**

In 2013, U.S. Congress enacted The Drug Supply Chain and Security Act with provisions that mandated pharmaceutical companies and drug distributors have a full unit-level track-and-trace system in place for products as they move through the supply chain in place by the end of 2023. All participants in the pharmaceutical supply chain are mandated to report any illegitimate drugs in the network within 24 hours. The FDA has also been increasing pressure on pharmaceutical companies to develop systems that can track, report and share information with the FDA across the various stages of the supply chain. This regulation was introduced largely to counteract a counterfeit drug market that has negatively affected millions of individuals worldwide. The World Health Organization (WHO) estimates that 1 in 10 medical products sold every year, with 50% of those occurring online. The WHO also estimates that 8% of medical devices in circulation are also counterfeit (World Health Organization 2017). This represents lost revenue to pharmaceutical companies and their distribution partners and grave danger to consumers worldwide.

**How Merck is Using Blockchain for Enhanced Security in the Pharmaceutical Supply Chain**

In late 2017, Merck announced a partnership with SAP, AmerisourceBergen and Cryptowerk to create an advanced track and trace blockchain network that can run on a mobile app. The technology uses barcode scanning to enable real-time visibility into the location of drugs wherever they may be in the supply chain. The blockchain network allows Merck employees, distribution partners and regulators to identify and track drugs by serial number, batch and expiration date.

Through blockchain’s immutability features such as permission and cryptography and consensus features such as smart contracts and PBFT, Merck is able to maximize the security of all participants in the supply chain. Blockchain’s smart contract functionality, along with the use of IoT devices, enables continuous drug tracking capability for participants in the pharmaceutical supply chain. The origin of a drug, its conditions, authority rights, and checkpoint approvals are able to be accessed at any point in time. This enhances the audit trail of every unit in the distribution channel. Any deviation from the

![Diagram](https://example.com/blockchain-diagram.png)

*Figure 1-4 (Source: Deloitte)*
Blockchain’s smart contract technology can also be used to follow regulatory statutes across the supply chain. Specific regulations can be coded into the transfer of drugs from one network participant to the other all the way down to the consumer. Once this process has been completed for a specific drug, blockchain’s distributed ledger technology allows regulators to retrieve a full history of product flows along the supply chain that can prove and ensure enhanced security.

Details regarding Merck’s adoption of blockchain are forthcoming, but an analysis of blockchain’s capabilities reveals a large additional benefit in enhanced security across the pharmaceutical supply chain. This case study analysis ties in perfectly with the typology analysis for the pharmaceutical industry.

Conclusion

There is still much to be studied in order to understand the reasons for which industries are adopting blockchain. This collection of case studies is but one variable to consider, especially as results from pilot programs and beta tests are premature and have yet to yield quantified sets of data that are available to the public for dissemination and further analysis. Nonetheless, it is clear that the seven key benefits of blockchain adoption to global supply chains are promising enough to warrant pilot and beta testing by industry participants.

Edited by Evan D. Poff

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Curious how blockchain may affect manufacturing businesses? Want to see what logistics companies care about when it comes to this technology? For Jonathan Chichoni’s analyses of the unique impacts on nearly 20 industries, as well as the complete thesis and bibliographical matter, visit: https://scholarsarchive.byu.edu/marriottstudentreview/