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Case Study of Blockchain Applications in Supply Chain Management- Opportunities and Challenges

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Abstract

Blockchain and its related technologies start to present business values recently. This research analyzes blockchain adoption within the field of supply chain management by looking at companies that have already put blockchain technology into practice. Fascination and doubt have grown exponentially with Blockchain technology and with cryptocurrencies in general. Since blockchain technology is relatively new, there is much to be looked at with thinking about its impacts, good or bad, on the field of supply chain management. This research investigates the challenges that companies will face and potential opportunities when adopting blockchain applications. Overall, the research question is What are the opportunities and challenges of blockchain adoption in Supply Chain Management? This research conducts a case study of blockchain adoption within real companies. Different effects of blockchain on various aspects of supply chain management are discussed and analyzed.

Keywords: Case Study, Blockchain, Technology Adoption, Supply Chain Management.

1. INTRODUCTION

Blockchain was first introduced to the public in 2008 after Satoshi Nakamoto, whose real identity remains secret, released the whitepaper "Bitcoin: A Peer to Peer Electronic Cash System" (Marr, 2018). Nakamoto's whitepaper describes bitcoin as a "purely peer-to-peer version of electronic cash." The original purpose of bitcoin was to address double-spending, which is often a problem faced by digital artifacts. Digital tokens are known to be easily copied and spent

multiple times, which is fraudulent. Copying digital tokens and spending them multiple times can cause inflation by creating massive amounts of money that were not previously there.

Since blockchain is the technology supporting bitcoin, it caused significant interest in blockchain technology to gain traction worldwide. Fascination since the whitepaper has grown exponentially for both blockchain technology and cryptocurrencies in general. Today, companies worldwide are exploring ways

to incorporate technology into pre-existing business activities to meet new performance goals. Blockchain is a shared digital ledger that cannot be altered and facilitates business transactions and tracking assets in a business network. These assets can be tangible or intangible.

To fully understand blockchain, it is crucial first to understand distributed systems. At its core, Blockchain is a distributed system, which is defined as a "computing paradigm whereby two or more nodes work with each other in a coordinated fashion to achieve a common outcome" (Bashir, 2017). It is modeled in a way that allows end-users to see it as a single logical platform. A distributed system is essentially a group of computers working together to appear as a single computer to the end-user (Kozlovski, 2018). The machines within a distributed system have a shared state but can fail independently without causing a huge problem, making them incredibly secure.

Unlike a typical financial ledger, Blockchain allows for parties to transact without using a central authority to validate the transactions (Jaikaran, 2018). Typically, the central authority is a third party, such as a bank or another financial institution. Transactions within the blockchain are not limited to financial ones. It may also include tracking items, identity logging, verifying complete actions, or any other activities not mentioned. In blockchain technologies, there is no need for a third party. The transactions are added, the identities of the parties conducting the transactions are verified, and the transactions are verified before putting them into the ledger as a block. Since each transaction block depends on the previous block, any change made will alert all users of change to the history of transactions, making it incredibly secure for all parties. Also, relationships between identities, transactions, and the ledger allow for parties to have a higher degree of confidence in the state of transactions (Jaikaran, 2018).

Overall, the research question is **What are the opportunities and challenges of blockchain adoption in Supply Chain Management?** This research conducts a case study of blockchain adoption within real companies. Different effects of blockchain on various aspects of supply chain management, such as quality, efficiency, and traceability, are discussed and analyzed.

2. BLOCKCHAIN TECHNOLOGY MARKET

Blockchain technology is one of the most promising upcoming and technological trends in the information technology domain (Grand View Research, 2019). The global blockchain technology market was valued at USD 1,590.9 million in 2018. It is expected to grow at a compounded annual growth rate of 69.4% from 2019 to 2025, according to a new study conducted by Grand View Research, Inc.

Currently, the annual value of fraud and cyber-attacks within the Banking, Financial Services, and Insurance (BFSI) sector is estimated to be thousands of millions of dollars. This has become a challenge for companies globally. To overcome this problem, companies like Microsoft Azure and Deloitte are focusing on offering blockchain-as-a-service. Improved penetration in deploying "Proof of Concept" solutions by leading providers of blockchain technology and the rising need for faster and transparent transactions across various industries is expected to propel the market's expansion during 2018-2025.

As technology applications in business processes are growing, the need for solutions such as blockchain technology is expected to disrupt current activities. One of the main drivers of blockchain adoption is the growing adoption of distributed ledgers among banking and financial institutions (MarketWatch, 2019). This is one of the significant portions of blockchain technology. Another driver within the market today is the rising capitalization of cryptocurrencies. As mentioned before, Bitcoin and Ethereum are prime examples of cryptocurrencies. The growing need for technological solutions is also a driver within the market for blockchain technology, especially in more prominent companies with many resources to focus on. Another driver for adopting blockchain technology is the increasing venture capital investment in Blockchain and Initial Coin Offering (ICO). ICO is the funding of cryptocurrencies.

Researchers have found that more and more companies believe that blockchain technology will be critical within the next 24 months (Deloitte Insights, 2019). In a study by Deloitte, 53% of respondents believe that technology will be vital within the top 5 strategic priorities. More respondents now than in 2018 believe that blockchain technology is broadly scalable and can be utilized in many different industries. Blockchain's maturation is expected to continue

as an overall investment in the technology increases. This supports the notion that in the long term, blockchain technology has much potential. Taking a closer look at companies putting into place blockchain technologies, we can see the positive impact on supply chains.

3. CASE STUDY

Walmart

Walmart is one of many industry leaders that is putting into place blockchain technology initiatives. For example, Walmart Canada has launched the "world's largest full production blockchain solution for any industrial application" (Retail Info Systems, 2019). This initiative is a partnership between Walmart and DLT Labs; a company solely focused on developing blockchain solutions for enterprises. The new system uses distributed ledger technology to track deliveries, verify payments, and automate payments. It also follows reconciliation between Walmart Canada and its carriers. The company's carriers deliver products to over 400 retail stores across Canada annually. Walmart Canada went live with the operations in February of this year after completing two pilot programs with IBM: one for pork and one for mangoes.

Walmart worked with IBM to design and implement food pilots using blockchain technology. According to McDermott, "Blockchain solves business problems where trust is part of the solution" by providing what traditional databases cannot, which is data immutability as well as speed and security and dissemination (Kamath, 2018). IBM's solution was based on Hyperledger Fabric, which supports modular architecture as well as plug-and-play components. Records within the system include audits, agricultural treatments, identification numbers, manufacturers, known security issues, granted permissions, and safety protocols. This data is logged in real-time and is permanently stored for future use. The technology is thought to provide trust, enabling higher efficiency and complete sharing of data, which is highly useful in supply chain environments and business in general.

Walmart uses this technology in China to ease consumers' worries regarding food safety in growing food automation (Kamath, 2018). In October of 2016, Walmart launched the Food Safety Collaboration Center, where the center studies foodborne contaminants and develops risk assessment models to use other companies. Walmart has also invested in technologies to detect foodborne pathogens and to monitor

package food contaminations. The cooperation with government agencies was crucial to the success of Walmart's pilot programs.

Blockchain technology enables food traceability down to the item level, rather than batch level or even facility. Walmart's initiative helped to identify which information is essential to track. This allows for data categories to be documented as mandatory or optional, as what data can be cut out of the tracking process. This document provides for the amount of data to be manageable and keeps the process efficient. The pilot program also ensures the reliability of data collected and works out all potential problems that the company would otherwise face.

Coca-Cola

In November of 2019, Coke One North America (CONA) announced that they would be deploying blockchain technology (Williams, 2019). Coke One North America is the technology firm that manages IT operations for Coca-Cola's bottlers. The company is currently utilizing SAP's blockchain technology to shed light on its many transactions each year.

The blockchain technology allows bottlers to see into the inventory of other suppliers, allowing them to purchase the items needed to fulfill demand if not already on hand. The technology helps CONA by processing those transactions at a faster pace, making the company more efficient. Torsten Zube, who is head of the SAP Innovation Center Network, believes that the blockchain technology is creating a document flow across the supply chain for CONA (Williams, 2019). The SAP Innovation Center Network is tasked with finding use cases for the new emerging technology. Using the tool, CONA hopes to spur greater productivity, increase cost savings, and speed up cash flow between the different franchises.

The pilot program originally started between just two bottlers, Coca-Cola United and C.C. Clarke. This program has been scaled across all bottlers after seeing improved results. With the technology put into place, franchises can see if an order can be fulfilled and leads to necessary adjustments to happen faster. Blockchain technology also allows CONA to dispute transactions quicker and more effectively since it can now see all the online ledger transactions. The technology makes the transactions clearer and more transparent.

UPS Case

Early 2019, UPS announced its partnership with Inxception, creating the platform Inxception Zippy. It aims to set up shipments and send shipments easier going from business to business within the marketplace. The platform helps businesses market and distribute their products on multiple online channels, making it more secure (Conwell, 2019). The platform allows merchants to quickly set up an account that enables manufacturers, distributors, and wholesalers to be more connected and conduct e-commerce transactions. Since technology is blockchain-backed, sensitive information is ensured to be safe. The information collected is only available between the buyer and seller. The partnership between UPS and Inxception allows for a more seamless end-to-end experience. Since the partnership involves UPS, merchants can view their entire supply chain every step of the process.

UPS has also partnered up with HerdX, which provides end-to-end insights into food supply chains. The partnership between UPS and HerdX has already completed a test trial to use blockchain for beef traceability from a farm in the United States to Japan. HerdX's blockchain solution uses connected tags, readers, and verified data, much like Walmart (Ledger Insights, 2019). HerdX monitors both animal movement and health to ensure the best quality beef for consumers. UPS's partnership with HerdX allows for live updates of the product from farm-to-table essentially.

HerdX's blockchain collects data such as the animal's birth, where the herd was raised and enabled farmers to keep a watch on each animal. Since UPS is a transportation company, HerdX and UPS's partnership allows for the business to track shipments using blockchain throughout the entire supply chain process. UPS Logistics and Freight provides services for over 200 countries worldwide, which gives HerdX the massive scalability power to provide for cattle producers worldwide, changing the entire industry as more and more companies utilize the technology.

In the trial, a shipment of beef left from Kansas in one of UPS's temperature monitoring packaging (Ledger Insights, 2019). The packaging had sensors monitored and recorded data throughout the shipment's journey. Once the package arrived at its destination, the data was recorded in HerdX's blockchain platform. Customers who want to look up where exactly a product came from can scan the QR code to

view the verified health and data of the meat they are buying. This creates trust between both the customer and the farm. This case can also be applied to other products, not just food.

4. ANALYSIS

Efficiency

There are many potential applications and benefits of utilizing blockchain technology within supply chain networks. One of the main advantages of deploying blockchain technology is to improve efficiency for everyday business activities such as communicating with business partners, completing transactions, tracking documents, as well as much more. For example, the use of smart contracts is typically part of blockchain technologies. A smart contract is a self-executing contract where the terms of the agreement are directly written into code (Frankenfield, 2019). After being written into the lines of code, it now exists in a blockchain network.

Within the supply chain field, smart contracts can be used to automate the transfer of title to goods and money, which removes the need for third-party facilities. An example of this is Letters of Credit. The use of smart contracts helps to streamline the whole process. Also, since there is no need for third parties, the overall cost will be reduced, thus saving companies money in the long term. Smart contracts cause faster cycle times by reducing the amount of time it takes by creating a more efficient process.

Maersk's partnership with IBM is just one example of blockchain technology being implemented to improve efficiency. Through the use of blockchain technology, Maersk can more efficiently and effectively work with the company's partners. For example, the average end-to-end container shipment involves more than 30 organizations, more than a hundred people, and more than two hundred information exchanges. Through the use of technology, the process of sharing and collaborating with documents is streamlined. Blockchain allows for the transfer of data and information to be transferred at a much faster pace.

Transparency/Traceability

As globalization and growing complexities in the marketplace grow, supply chain transparency becomes exponentially more critical. Today, companies face many problems in the everchanging market due to a lack of transparency in supply chain networks. An

example of this is Coca-Cola's partnership with SAP to develop a blockchain solution to track and validate transactions between 0 different franchises (Battrick, 2019). Coke One North America (CONA), as mentioned previously, is the technology firm that manages IT operations for Coca-Cola bottlers. Currently, CONA oversees 12 suppliers with hundreds of thousands in orders.

Since Coca-Cola is so large, the technology's ultimate goal is to increase efficiency, reduce cost, and accelerate cash flow in the company's supply chain. Coca-Cola's supply chain is currently worth \$21 billion in yearly revenue, which is a massive amount. With SAP's blockchain solution, CONA can reduce the duration of order reconciliation from 50 days to just a few days (Huillet, 2019). This drastically improves its efficiency as well as provides the company with more insights. The technology also offers real-time insights into shipment information and the transactions made by all the different bottlers on the Network. As an example, let's say a bottle maker is short of stock for an order. The Network will quickly provide options for filling the shortfall. This allows for fewer shipping errors, less missed deadlines, and lowers operational costs as a result.

If more companies were to implement technology, transportation costs across many industries would be significantly reduced. This is because they would get shipments faster and have less cost associated with the holding of shipped items. This would also allow for increased transparency, giving companies better insights into how its efficiency is and would provide companies the opportunity to invest more into components of its business practices rather than efficiencies.

Walmart is also utilizing blockchain technology to improve transparency within its supply chain. There is no widely adopted industry standard for how the food industry tracks and records data for traceability purposes. Companies within the industry will often record data on paper, while other companies use digital methods to track. While some companies are using these digital methods, there is no way for companies to communicate effectively and efficiently. The current system for food tracking is highly limiting transparency for all organizations within the industry. Since the system is lacking, Walmart is leading the industry in creating a solution to this problem (Yiannas, 2018).

UPS has also started to use blockchain technology for its operations. Last year, the company applied for a United States patent to use blockchain technology to track packages through multiple carriers globally. This technology allows the company to track international air freight shipments and verify shipments. Also, in 2017, the company joined the Blockchain in Transportation Alliance. This is a group of corporations that set a standard of utilizing blockchain technology in transporting products. Having a set standard is beneficial because the more companies that operate blockchain, the better off they are using the technology. Having other businesses within the same industry utilize similar technology allows for the technology to grow, and each company can learn from each other.

Quality

Blockchain technology also can provide many insights for companies looking to improve the visibility of its entire supply chain and increase efficiency and improve product quality. One way to enable higher quality products is by providing essential information such as environmental aspects when transporting goods throughout the entire process. By providing critical information, manufacturers can pinpoint exactly where problems may occur.

By looking at the food industry, this can be seen very easily. For example, if a truck is transporting milk, strict temperature guidelines must be followed to keep the product healthy for customer consumption. Blockchain technology can track what temperature the truck is transporting the goods and information regarding if the product is spoiled or not. If a truck thermostat topped working, the company would be able to see that the temperature is wrong and pinpoint precisely when it malfunctioned. This would allow the company to identify precisely which group of products is affected by the malfunction, enabling the company to save time and money by knowing which products need to be thrown away.

This type of example can be transferable to all other products. Another example of this is cars being manufactured. Recalls are widespread within the car industry and cost manufacturers a lot of time and resources each year to fix. Often when a part is recalled, the company does not know which exact cars have the defective part. If car manufacturers were to put into place blockchain technology, it would save the company a lot of time and resources by enabling the company to see where exactly the defect

happened and which cars were affected instead of the company guessing a large batch of vehicles. This would allow for fewer resources to be wasted, saving the company a lot of money each year.

Vulnerabilities

Since the technology is so new, there are many potential problems that companies should be aware of before deciding to implement blockchain technology. One problem with blockchain technology is double-spending. Although blockchain technology was created to combat the problem of double-spending, it can still happen. Double spending is a fundamental problem that businesses could face after implementing blockchain technology. Double spending occurs when a user makes multiple payments using one funding form. This can appear because transactions are validated by solving a mathematical problem. When unprocessed amounts are broadcasted across the Network, broadcasting disruptions can happen, causing double-spending (Hasanova et al., 2018). For example, an attacker could trick a retailer into accepting a transaction that the retailer cannot reverse by doing the following.

In this scenario, the attacker could start a transaction just like the original except change the recipient's address. If both transactions are initiated simultaneously to peers on the chain, the chain will not accept multiple transactions that share common inputs. Instead, they will only accept the version of the transaction that reaches them first. Although, the transaction could go out to other peers, making it successful in causing double-spending. There is no way for companies to get around double-spending; it will always be a potential threat.

Another potential challenge faced by companies implementing blockchain technology is a 51% attack. Both a 51% attack and double spending can happen at any time, meaning companies must know this possibility. A 51% attack refers to miners controlling more than fifty percent of the network hash rate, which is the computing power. During this attack, an attacker could be able to obstruct the confirmation of new transactions. An attacker can also reverse transactions, but only if they hold the majority power over the Network. This could cause double-spending. Although a 51% attack could happen, it would be tough for an attacker to take over the blockchain. This is because transactions are locked before the start of an attack if the attempt has to do with historical blocks.

In August of 2016, both Ethereum Krypton and Shift experienced 51% attacks. While they experienced the attacks at low levels, a 67% attack would cause severe problems to a company (Hasanova et al., 2018). At the 67% level, the attacker can essentially block and reject any transaction they want to. They can also form any transaction themselves. To combat this, precautions must be set into place to make sure that something like this does not happen. Also, companies should take necessary measures to protect themselves and to protect customers within the system.

Another challenge of blockchain technology is that it takes up a large amount of energy and can be costly. Currently, developers are looking into ways to make blockchain technology more energy-efficient and develop the technology to be faster than it already is. One way developers are looking to make the technology more efficient is by enabling parallel processing. This allows for simultaneous transactions to be processed. Some recently developed technologies can process thousands of transactions per second, making the technology highly scalable.

Also, while there is a lot of growth within the industry in developing blockchain technologies and implementing it, there is still not a standard for the technology. Since there is no standard, companies must figure out how to either develop their own technology or implement an already developed technology version. This can cause massive amounts of money to be invested and to be improperly used. This would essentially be creating a technology that will not be used and would burden the company. Although this is an issue, as more companies utilize the technology, standards will be developed, thus benefiting all companies utilizing similar technology.

5. CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH DIRECTION

Blockchain technology can prove highly valuable for companies willing to learn new technology and be willing to take some risks. While blockchain technology is fairly new and evolving, many potential benefits make investing in technology worthwhile. Some of the benefits seen are improved efficiency, transparency, and traceability and the ability to enable higher quality products to be sold to consumers. Blockchain does this by providing distributed ledgers that are immutable and provide real-time data regarding shipments and provide

access to documents needed throughout the supply chain process.

While improving efficiency, transparency, and traceability, the technology allows a company to save money by producing products more effectively. Blockchain technology enables companies to spend less time completing tedious tasks without the use of blockchain. Activities such as shipping details, tracking details, and much more can all be stored in one place and accessed by various company groups. This data can also be shared with people outside of the company, making collaboration easier to accomplish, enabling greater productivity and higher cash flow.

While there are many benefits to deploying blockchain technology, there are also potential issues that need to be thought about before scaling the technology company-wide. This is why companies such as Walmart, Coca-Cola, and UPS do pilots before fully committing the technology to their entire organization business practices. Some of the risks include double-spending, cyber-attacks, high energy costs, and high set-up costs. While the technology was created to combat the problem of double-spending, it can still happen. Keeping this in mind, companies can take protective measures to help ensure their information is secure.

Since technology is online, there is always a potential of cyber-attacks. This can take form in many different ways, one of those being a 51% attack. Companies such as Ethereum Krypton and Shift have both reported this kind of attack happening to them. As the problem of double-spending, companies should take countermeasures to ensure that their information is as secure as they can make it and be careful about which data is stored. This can prevent anything wrong from happening to the company's data.

High energy cost and high set-up cost can also be avoided. Companies will often provide the software as a service, enabling organizations to focus more on its practical usage rather than deal with the high costs associated with maintaining it and developing it. In many cases, there is at least a framework developed which will save costs. Also, blockchain technology's adoption will save companies more money in the long run, making the investment worth the high set-up costs. Overall, companies should weigh both the potential benefits and challenges that are associated with blockchain technology.

Limitations

This study's main limitation is that there is little to no quantitative data to measure the direct impact of blockchain technology on supply chain networks. This study's research is mostly based on theory and not necessarily have data to back it up. As more companies introduce technology, the association between technology and its impacts will be more measurable. Since the technology is so new much of the data regarding its direct impacts is kept secret within the company itself. It is not out there for public access. Also, as more companies use the technology, the data will become more accessible, and a conclusion regarding its impacts on a supply chain will be directly seen.

Future Research Direction

This research looks at qualitative data drawn from real company case studies and draws conclusions based on that. In future research of the topic, quantitative research should be addressed to add to assumptions already made. As the data becomes available, it will allow for a more holistic view of the direct impacts of blockchain technology on supply chain networks. The direct costs associated with the implementation of blockchain will be addressed as well as the amount of cost savings for each company. This will allow for both researchers and companies looking to implement the technology to plan ahead better, as well as provide them with the knowledge to make business decisions regarding the technology. As more companies implement the technology, its impacts on other areas besides efficiency, transparency, traceability, and quality can be addressed. Research in these areas can also be added to, providing more research overall.

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