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Blockchain and Consumer Trust

Introduction:

Blockchain is an immutable digital ledger that is appended to by every part of the supply chain. This means that it is an unchangeable virtual record of everything that has happened to a product from its humble beginnings as raw materials, to the moment it reaches the hands of its consumers. Blockchain was originally created to ensure that the digital currency Bitcoin was legitimate, and to make buying, selling, and trading the digital currency something that had value (Swan, M). However, engineers quickly discovered that its uses could reach much further than a digital dollar. “What started as a rogue experiment in the financial world has not only proven successful but is changing the way the world is looking at securing transactions today “ (Das, A., 2018).

For physical supply chains, the technology relies on a mix of Internet of Things (IOT) devices as well as manual inputs. IOT devices are devices made to connect non-technical objects to the internet. These devices can keep track of temperature of goods as they travel, their location, or how they are stored. These devices upload information to a ledger that everyone involved in the supply chain can access. The farmer updates the same ledger as the store that sells them. These ledgers can also be updated with information manually, such as who was responsible for harvesting the produce. Since there are multiple access points in the blockchain,

it appears to be vulnerable to fraud. However, it maintains its credibility because once something is uploaded, it cannot be changed. Mistakes are fixed by appending a second entry in tandem with the original, as well as a description of the error and the corresponding signatures.

Blockchain has since been used for tracking diamonds, monitoring votes, temperatures, car parts, and anything that people have a vested interest in tracking (Swan, M). One of the most compelling uses of blockchain technology is how it can be used to monitor the supply chain of food from "farm to fork." This ensures businesses and customers alike know where their food came from, and what happened to it along the way (Parker, L., 2019). In big food distribution firms, such as Driscoll's Berries, blockchain allows distributors to know which of Driscoll's independent farmers grew the berries, which cooling facility it went to, and to which store the product was shipped. With such a long and complicated supply chain, it would be near impossible to determine where within the supply chain something went wrong. Blockchain tracks every step of the way.

The use of blockchain technology is going to change the nature of traceability completely. Traceability is the cornerstone of the food industry. Without it, firms do not know if their food is safe, and customers do not know what they are consuming. Blockchain has already proved to be successful for large-scale grocery stores and suppliers. It has even revolutionized entire industries, such as cattle farming. Using consumer behaviors regarding similar changes to agriculture, such as nanotechnology, and ongoing research about consumer behaviors relating to Blockchain, the success of Blockchain is expected.

Traceability on the Supply Chain

Blockchain is most powerful when it is shared along the supply chain. Supply chain is the "network between a company and its suppliers to produce and distribute a specific product to the final buyer" (Kenton, W). The current model of traceability, known as the "one-step up and one-step back approach" only requires producers to know where the product came before they received it, and where it is shipped. The traceability of a good is highly dependent on each firm keeping adequate records, and that their records cover the data that is needed. Thus, when discussing blockchain, it is important to view each participant in the supply chain as having equal responsibility for the quality and safety of the final product. All of the firms involved have equal power and responsibility on the blockchain ledger.

This is crucial during food outbreaks, like the E-Coli found in Romaine lettuce in 2018. The FDA and the CDC were able to find that the tainted lettuce was grown in the Yuma Region of Arizona. They were able to inform the producers, consumers, and retailers of where the tainted lettuce came from. However, this did not help determine what lettuce was bad (Redfield, Mounce, Mundo, & Yiannas, 2018). Health officials were unable to determine which produce was affected and which was not when the lettuce was sitting on the store shelf. "This resulted in millions of bags and heads of romaine lettuce having to be removed from the marketplace and a loss of consumer confidence in romaine lettuce, regardless of growing region, as well as negatively affecting the economic livelihood of many, including farmers" (Redfield, Mounce, Mundo, & Yiannas, 2018).

Traceability using blockchain allows anyone along the supply chain to go back and identify the "origin of food and feed ingredients and food sources, particularly when products are found to be faulty" (Banerjee, R., & Menon, H., 2015). Implementing blockchain-traceability

systems will allow safety and quality compliance measures to be created, tracked, and ensured (Banerjee, R., & Menon, H., 2015). Blockchain ensures this in a way that is transparent, unchangeable, and most importantly, fast.

Blockchain is the perfect fit for the agriculture industry because of its decentralized ledger. Instead of each participant keeping their own records, all participants append to one unchangeable ledger that anyone can access. Senior Director at Walmart Technology, Karl Bardwell states that "[c]reating a (traceability) system for the entire food supply ecosystem has been a challenge for years [.] We thought that blockchain technology might be a good fit for this problem, because of its focus on trust, immutability, and transparency." (The Linux Foundation, n.d.).

Blockchain's traceability is dependent on two basic ideas. First, there is an identification of all units or batches, and all of the ingredients and products that go into them. Then, The information is then registered whenever the unit is moved or transformed, and the data is then synced with the product. Finally, information is carried with the product to the next stages (Banerjee, R., & Menon, H., 2015).

Case Studies on Blockchain Implementation

Walmart:

Walmart was one of the first big firms to adopt blockchain. In 2016, Frank Yiannis, former VP of Food Safety, bought a package of sliced mangoes. He brought his team into his office, and asked them to find out where the mangoes came from. The selected professionals worked constantly for 7 days until they found the original source of the mangoes (The Linux

Foundation, n.d.). Yiannis said, “Our customers deserve a more transparent supply chain. We felt the one-step-up and one-step-back model of food traceability was outdated for the 21st century” (Miller, R., 2018). Together with IBM, Walmart developed a traceability system using blockchain. They ensured it was vendor-neutral and open-source to allow all involved parties to access it, including their competitors, so the full extent of the supply chain could be tracked.

They ran the test again, and it took 2.2 seconds to locate the original source of the mangoes (Miller, R., 2018)(The Linux Foundation, n.d.). The experiment proved successful and Walmart has expanded its blockchain use. Now, Walmart and its suppliers use blockchain to track produce, meat and poultry, dairy, and “multi-ingredient products” such as packaged salads or baby food (The Linux Foundation, n.d.).

Walmart has since begun the process of requiring more of their suppliers to switch to the blockchain system. In a letter written to wholesale distributor Leafy Greens,, they said, “All fresh leafy greens suppliers are expected to be able to trace their products back to the farm(s) (by production lot) in seconds – not days. To do this, suppliers will be required to capture digital, end-to-end traceability event information using the IBM Food Trust network” (Redfield, Mounce, Mundo, & Yiannas, 2018). Walmart has implemented the move to blockchain in two phases: direct suppliers and end-to-end. All direct suppliers were required to meet the ”one-step back traceability standards” by January 31st, 2019. The suppliers then had to work with their vertical systems to have traceability all the way to the farms by September 30th, 2019 (Redfield, Mounce, Mundo, & Yiannas, 2018).

Driscoll's Berries:

Driscoll's Berries is the biggest producers of berries in the United States Market. "The company has operations on five continents, and its independent grower base employs more than 115,000 farm workers who pick and package its berries, which are then sent to cooling facilities owned and operated by either Driscoll's or a third party partner" (Harris, J., 2016).Driscoll's also controls the market in organic berries. With 150 organic farmers, they take up 70% of the US Market Share (Pullano, G., 2019).

Driscoll has a huge supply chain. The berries are picked and packaged by the independent growers before shipment (Harris, J., 2016). These independent growers are located on 5 different continents. From there, the berries are sent to one of 56 cooling locations. The berries must stay cooled at 33 degrees from the moment they are packaged. The cooling centers then distribute to one of the 400 customer locations (Harris, J., 2016).

The Vice President of Supply Chain at Driscoll, Scott Komar, describes the supply chain as " always moving" (Harris, J., 2016). Ensuring the traceability of the berries is much harder than in other industries. "Unlike other produce items where you may harvest once, with berries, we're in the fields every day picking optimally ripe berries and feeding them into our supply chain, where they keep going all the way to consumers' homes" (Harris, J., 2016).

As one of the main berry producers for Walmart; Driscoll's was required to transition to blockchain. Driscoll's Berries uses blockchain to test food safety from its farms to Walmart's shelves (Solan, B. 2019). They piloted their blockchain implementation with four objectives. The first was to align with Walmart's requirements. The second was to test capturing data upon

harvest. Third, they wanted to create a Produce Traceability Initiative (PTI) compliant shipping label that also satisfied the requirement for being scanned into the blockchain ledger. Finally, they wanted to implement full cold chain visibility to ensure the berries stayed at 33 degrees throughout shipment (Solan, B. 2019).

These initiatives were a success. Shipments from the farm to the store are being captured and documented. Harvest data is now being captured as the berries are harvested in real time. They produced a compliant new label. With these successes, they gained almost full visibility from the beginning to the end of the supply chain (Solan, B. 2019). This is not without challenges. Since Driscoll's berries are grown on many different farms by independent growers, the data capture technology at harvest is not currently scaleable to everyone. Driscoll's is still looking for a solution to implement this data capture in a way that is compatible with some of its smaller suppliers.

Beefchain:

Blockchain is finding another agricultural niche in the livestock market. Market demand for "Grass-fed" beef is steadily increasing, as consumers pay high premiums for ethically sourced cows (2019, April 4). However, the profit is not going to the ranchers who work hard to raise their cows ethically, but rather further down the supply chain. The markup in price is mostly placed at the market level. Thus, the consumer does not know if their beef is even meeting the criteria they are expecting based on the high price . By implementing blockchain technology, consumers and farmers benefit from increasing traceability (Beefchain, n.d.). The technology applied to livestock is called Beefchain. Beefchain is used to identify animals, their

origins, and track their health throughout their lives. This identification in real-time allows for faster transactions and payments. Kamila Kudelska from NPR comments, “With blockchain, data like what the cattle eats, what type of vaccines it has received, and if it was ever sick will be available for anyone to see” (Kudelska, K., 2018).

Currently, each ranch uses their own method of tagging and tracking cows. Beefchain.io, the start-up pushing for blockchain in cattle farming, is trying to change that. Currently, it costs about $5 per animal to tag that contains IOT technology. These tags allow the cattle, and later the beef, to be identified all the way through processing. This level of transparency is estimated to raise ranchers’ profits by 10-20%. The end goal is to allow consumers to scan a code, and see information about the cow, where it came from, what medicines it was given, what it was fed, how and when it was killed, and everything else along the way (Radke, A., 2018).

CEO of Blockchain.io, Mark Jennings, reiterates the importance of traceability in the market. “[F]ood safety and guarding from food fraud, things being packaged that aren’t what they say they are” are among consumers biggest fears (Kudelska, K, 2018).

The Consumer

When discussing how blockchain will or will not revolutionize the agriculture industry, the consumer might be the most important factor in its success. If blockchain has little empirical value to the consumer, many firms might be reluctant to make changes to their supply chain; especially when these changes come with a learning curve and a cost. Upheaval of the current system is almost always met with criticism.

This is not the first time new technology has promised to revolutionize agriculture. Nanotechnology, a breakthrough technology which controls crops on a molecular level, is being used to protect against pests and prevent waste. By researching consumer reactions, researchers were able to conclude that"[t]here is substantial empirical evidence that both trust and risk perceptions influence public acceptance of new technologies" (Eiser, R., Miles, S., Frewer, L. J., 2006). Results from the study in nanotechnology found two key factors that affect consumer trust (Siegrist, M., Cousin, M.-E., Kastenholz, H., & Wiek, A. , 2007). First, customers are more likely to trust a technology if they already trust the company. Since IBM is spearheading the move to blockchain, consumers are more likely to trust the effectiveness of the technology. Additionally, consumers are more likely to use the technology if they know more about it. IBM has been doing a great job advertising blockchain, with public PSAs and advertisements explaining the benefits (Siegrist, M., Cousin, M.-E., Kastenholz, H., & Wiek, A. , 2007).

Further research has been done on traceability specifically that backs up these claims. The Food Marketing Institute (FMI) completed a study in 2018 about consumer behaviors concerning traceability (O'Neal, F., 2019). The results stated that 93% of consumers value transparency, specifically what is in the food they purchase and how it is made. 74% of shoppers say they would switch brands if a similar brand provided more information (Food Marketing Institute, 2018). Transparency takes on three forms: ingredients in terms they can understand, more information than what is on the package, and having that information be easily accessible (Food Marketing Institute, 2018).

Consumers have been reacting well to blockchain thus far. Abeshik Das of Wipro, a global IT company, remarked, "This decade will likely see the rise [] of blockchain and its

adoption in various walks of life and until a better technology disrupts its growth, there is no slowing this sheriff who is here to conquer and stay." (Das, A., 2018). The more companies showcase their trust in blockchain, the more consumers will trust it as well. Early adopters are benefitting from blockchain implementation, and communicating their success to consumers. IBM has also brought companies like Carrefour, Nestle, Dole Food, Kroger, and Unilever into the fold (O'Neal, S., 2019). This translates well into the public's perception of the technology. Additionally. contrary to nanotechnology, blockchain does not affect the biological makeup food or transportation of a good, it merely tracks it. Nanotechnology changes the genetic makeup of a crop, which is much more difficult to understand and accept.

Challenges

With the seemingly inevitable success of blockchain technology, implementing it everywhere seems like the next logical step. However, that is not necessarily the case. There are many roadblocks to implementing blockchain in a system.

First, even though the data is traceable and immutable, there is no guarantee that the information given to the ledger is correct. John G. Keogh, a research associate at Henley Business School and the University of Reading, mentions, "things go wrong in food chains and the need to correct a record is a reality hence we need more research and discussion on the value and need for 'mutable' blockchains" (O'Neal, S., 2019).

Second, some data is hard to transform in a way that is compatible with the technology. This is because of the wide array of how people record and update their data. In a statement given to Cointelegraph, The COO at blockchain-based startup Ripe.io, Rachel Gabato, said, "As

we have engaged with farmers in the food areas of dairy, meat, produce, citrus, commodities, a primary challenge is the access and availability of data. Farmers capture data in many different forms and the ability to digitize this data for capture and sharing has been our primary challenge" (Boddy, M., 2019).

Third, the implementation of blockchain is not a good solution for traceability for all firms. Blockchain is expensive. It is time consuming to implement, and can change processes that have been set in place for years. Small firms, such as local farms, do not necessarily have a need to implement blockchain technology. In these cases, the costs of the technology far outweighs the benefits. Blockchain's strength is tracing goods across multiple firms. Small farms typically have much smaller supply chains, and some are entirely vertically integrated. For these firms, it does not make sense to implement blockchain. It is possible to trace goods in a much cheaper but equally effective way.

Even when beneficial, implementing blockchain can be a daunting task. In the Walmart case study, Yiannis and his team found a few key takeaways on how to create a successful blockchain. He recommends making the project business led instead of IT led. This allows the business to focus on their needs and how blockchain can solve them, instead of trying to shoehorn their current system into the blockchain environment. He recommends starting small, but having a lot of people on board with the transition. Through the example of Walmart and Blockchain, we have seen how the changes produce a domino effect in the industry.

Policy Suggestion

The FDA has a Food Code which summarizes their goals and expectations for food policy and safety in the United States. Last updated in 2017, this food code acts as "model that assists food control jurisdictions at all levels of government by providing them with a scientifically sound technical and legal basis for regulating the retail and food service segment of the industry" (US Dept. Of Health and Human Services, 2017). Based on the policy goals of the FDA, it is clear that blockchain is the solution. The preface of the Food Code indicates the extreme need for intervention in food safety. The preface states that it is "estimated that foodborne diseases cause approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths in the United States each year" (US Dept. Of Health and Human Services, 2017). It further elaborates on the estimated annual cost of "pain and suffering" related to food-borne illnesses are estimated between $10-$83 billion (US Dept. Of Health and Human Services, 2017).

The epidemiological outbreak data shows that there are five major factors that cause risk to consumers. These are improper holding temperatures, inadequate cooking methods, contaminated equipment, food from unsafe sources, and poor personal hygiene (US Dept. Of Health and Human Services, 2017). While blockchain cannot change behaviors of restaurants and individual firms, it can track them. Blockchain technology can ensure food is held at the proper temperature; it can ensure the source of the food from a safe source. Problems will be recognized early, and mistakes that would be damaging to public safety can be solved before the goods hit the store shelves.

For these reasons, Blockchain should be implemented in large food supply chains on a national level. The availability of information and guarantee of food safety can comfortably fix the fears of two of the five biggest concerns of food safety in a comparatively inexpensive and non-intrusive way. To offset some of the high initial costs of adopting the technology, the Government should provide incentives such as tax breaks or subsidies. This will encourage more firms to adopt the technology and improve the safety of their goods.

Conclusion

Despite the many challenges regarding implementation, Blockchain technology is built to last. There is a social benefit and a financial benefit to migrating to this technology. "Resource-intensive industries [such as agriculture] report significantly higher [return on investment] from direct and indirect in sustainability programs than many other industries" (Wilkins, K, 2016). Companies will be able to ensure quality in their goods from start to finish. Damaged or tainted products will be caught earlier and at traced to the source, which will also lead to less food waste, and less bad press in the case of a major outbreak like E. Coli.

Gabato from Ripe.io, commented, "One of the primary drivers for food providers to consider blockchain technology is the ability of the technology to collect data from various sources and create a single view of the transaction. This plays an important role in the ability to track the food product back to its origin driving more efficiency when a food safety issue arises" (O'Neal, S., 2019). This is a key goal for producers, and one that is best solved using blockchain.

Research firm Gartner Inc predicts that "20% of the top global producers will use blockchain by 2025" (Boddy, M., 2019). As development continues into making blockchain

more accessible for producers, suppliers, and consumers, the systems will mature. Maturing systems will lead to a decrease in costs along the supply chain. Errors and safety concerns will be caught early and often. Traceability systems will grow clearer, with a better insight into exactly what is happening to the crop or livestock at all phases of its growth and development. Consumers will have access to food they know is safe, and therefore will trust their products more. Blockchain will completely revolutionize how we perceive the quality and safety of our food.

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