Food safety verification by block chain; a consumer-focused solution to the global food fraud crisis

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Contributed paper prepared for presentation at the 64th AARES Annual Conference, Perth, Western Australia 12-14 February 2020.

FOOD SAFETY VERIFICATION BY BLOCKCHAIN; A CONSUMER-FOCUSED SOLUTION TO THE GLOBAL FOOD FRAUD CRISIS.

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January, 2020

1. Abstract

Food fraud is an age-long challenge motivated by economic reasons. Research has shown that food fraud costs at least $65 billion globally. Food experts tagged 2018 as the year of food fraud and fraud prevention strategies due to the shocking amounts and forms witnessed. Various certifications to combat food fraud, numerous certification programs have been launched. However, false labeling, which is the act of claiming food attributes that have not been obtained by food producers on product packaging, has ensued and become famous in developing countries. This new challenge has increased the need for a food safety verification system that enables prospective consumers to verify the authenticity of food products as quickly and as conveniently as possible.

In 2008, blockchain technology made its public debut, and in just over a decade, it has shown potential for usefulness in every sector, including agriculture. It gained the public trust and full acceptance because Blockchain technology is distributed, utilizes cryptography, is open, and has timestamps on every data recorded. Due to the combination of these features, it is considered unique and the most secure data framework for big data. Given the features of the blockchain system listed above, it is considered a more effective tool for food authenticity verification. The combination of blockchain and Internet of things, digital passports and mobile phones will undoubtedly proffer a fast and effective solution to counterfeit labeling issues in the global food industry, but this is also dependent on its level of adoption.

2. INTRODUCTION

Food fraud, an age-long issue, is the term used to describe the intentional and deliberate adulteration, substitution, addition, tampering or misrepresentation of food, food ingredients, and food packaging for economically motivated reasons. It is a public health risk that is gaining more popularity and becoming of more concern to stakeholders because it results in public health vulnerabilities for affected individuals and communities.

While food fraud is deliberate and intentionally motivated by economic reasons, food safety incidents are not intentional acts, although unintentional harm may occur as a result of this. Food fraud is considered to be of more severe risk as the contaminants are often of unconventional sources and types.

In recent years, there have been numerous cases of food fraud that have made the headlined and caused a disruption in global food markets. Some examples include the Spanish olive oil scandal in 1981 which claimed the lives of over 1,000 persons in Spain, the Chinese milk scandal in 2000 implicating huge corporations such as Nestle which led to the hospitalization of over 300,000 people, the American pet food scandal in 2008 which claimed the lives of thousands of pets and the Irish beef scandal popularly known as the 'horsemeat scandal' which erupted in 2013 and led to a drastic reduction in the consumption of beef products such as frozen burgers and a steep devaluation of Tesco.

With the ever-evolving consumer behavior and access to technology, value chain actors, policymakers, agribusiness investors, and, most importantly consumers, are increasingly demanding transparency and fairer supply chain systems. Unfortunately, this has not been achieved across value chains as issues surrounding unverifiable sources, unfair wages for agriculture workers, food safety issues, etc. persists (Wognum et al., 2011). To some extent, much more organized food stakeholders in developed countries can trace their food source and credence values. However, most customers cannot as they are forced to believe the claims on food product labels. With the continuous emergence of food fraud cases across the world, food consumers desire trust, and traceability within food value chains and Blockchain Technology (BCT) poses a substantial solution to the trust issues in food supply chains.

3. Blockchain and its features

Since its inception in 2008, Blockchain's potentials have become more evident. It possesses characteristics that make it a perfect solution to the trust and verification challenges associated with food fraud. They include;

- **A decentralized database:** Blockchain utilizes a decentralized data storage system, which implies that consumers do not necessarily have to consult any stakeholder organization or body to verify the specified credence attributes of food products. These stakeholders have not been able to monitor food values thoroughly and have, in worse cases, misrepresented the values of food, leading to a buildup of trust amongst consumers. A decentralized system ensures that relevant information is accessible to consumers and prevents modifications or alterations of the information.

- **Distributed data**; Unlike other forms of data that are stored on only one computer and accessed over the internet or other computers, blockchain is duplicated across many computers. This duplicity makes it almost impossible to modify as not one person has access and control over the files.

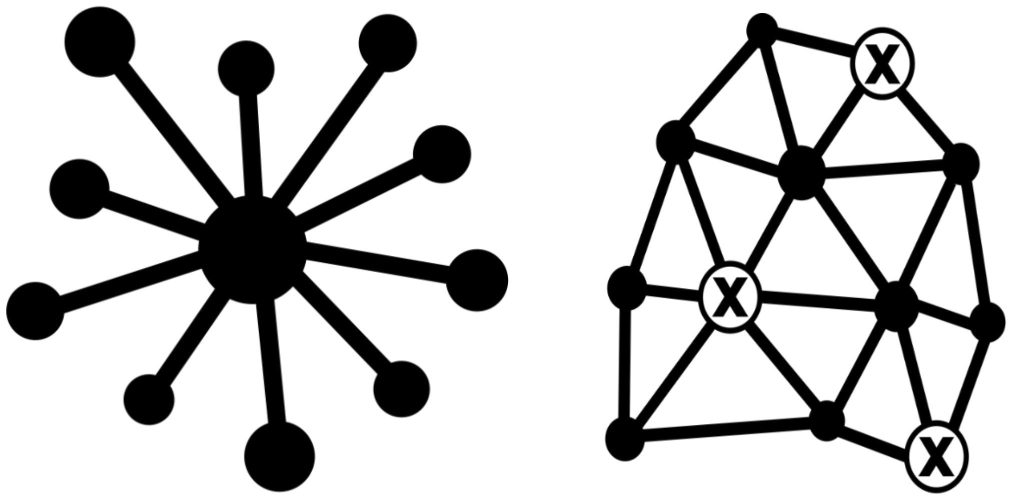

Figure 1 showing a centralized system versus a distributed system

- **It utilizes cryptography**; Cryptography utilizes secret codes to store data; thus, making the modification of data more difficult as one would need the access keys to change the data across the numerous computers that carry it. This translates to difficulty in the falsification of food data.
- **It is Open;** Blockchain data is stored in the public domain and can be accessed by everyone with access to the network. With the aid of a **digital passport** such as *barcodes and QR Codes*, consumers can access relevant information about their food.
- **Timestamps:** The timestamps on blockchains showed when the information was recorded. This can provide clues on how accurate the listed production dates are. The closer the production date is to the time stamp, the more believable they would seem and vice versa.

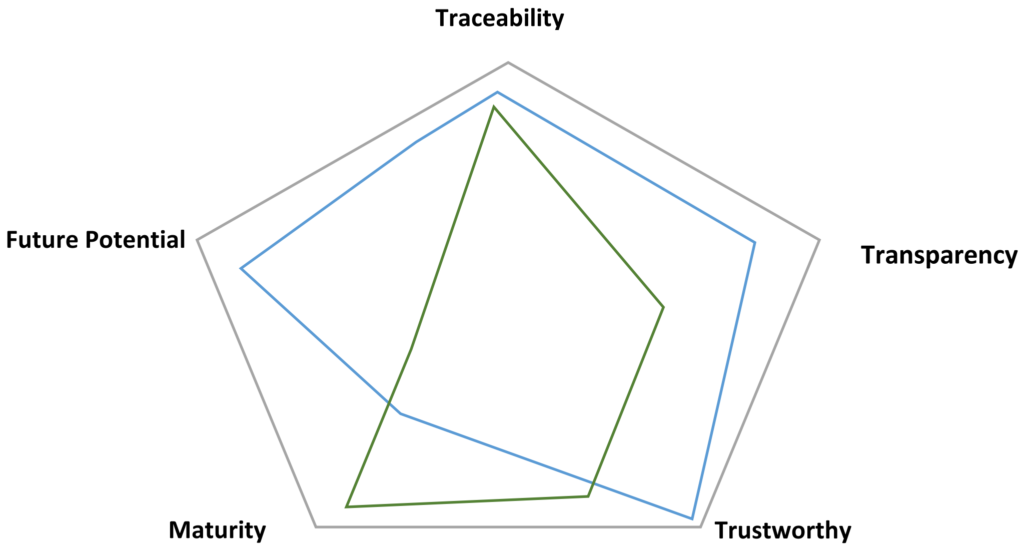

Figure 2 showing a Spider chart of a blockchain (Blue line) versus a centralized system (green line)
Source: Galvez, J.F, 2019

Comparing the blockchain system to the centralized system, the image above shows us that BCT is traceable, has got a huge future potential, operates a very transparent system, is trustworthy, but lacks maturity as it is a relatively new technology. On the other hand, a centralized system of food verification also possesses traceability features, lacks future potential, transparency, and trust but is quite mature compared to the BTC.

BCT has attracted much attention, mainly due to its unique way of carrying out financial transactions in a way that eliminates the need for a trusted third party, such as financial institutions (Tapscott & Tapscott, 2017). While BCT has much to offer the financial sector, the agricultural sector is also starting to experiment with the technology as financial transactions are inherent to value chains and food systems.
Agri-food BCT applications currently range from traceability and payments to innovative smart farming techniques (CTA, 2018). In the case of traceability applications, BCT creates a ledger where production and supply chain actors can always store and view information.
Once logged on the blockchain, information is saved in unchangeable “blocks,” which trace the path that a specific product took, from the producer, transporter, retailer, and

eventually to the consumer. Customers can access this information by just scanning the digital passport being utilized by the product such as QR Codes, an SMS shortcode, and so on.

The proliferation of food fraud events globally has led to a reduction of trust between food stakeholders and consumers and a corresponding increase in demand for food verification. Despite the presence of numerous organizations accessing and certifying credence qualities of food products, the unfortunate events have remained, costing the food industry an estimated 64 billion dollars annually (PwC Agribusiness advisory).

4. Methods

Qualitative research involving the literature review of peer-reviewed articles, blog posts, reports, op-eds, and case studies were carried out to produce this paper. To further understand the reach and progress of blockchain application in the agricultural sector, already existing programs running on the blockchain platform were analyzed and studied. Some of these programs have been launched by **Fairfood** in the Netherlands in collaboration with the Wageningen University to track traceability and incomes received by the farmers.

5. The current State of Food Traceability and Verification

The majority of traditional agricultural logistical systems track just orders and deliveries of agricultural produce and products. Features such as traceability, farmer income, food credence attributes, and food safety were not priority attributes being tracked by food consumers and are just gaining popularity in the sector. The prevalence of asymmetrical information between value chain actors and consumers indicates that consumers can never vouch for or trust the information presented of food labels. Given the importance of traceability and food credence attributes to food safety, consumers have increasingly requested the ability to verify food label claims. (C. Verdouw et al., 2013)

There has been a successful utilization of the Internet of Things for traceability of food. This is observed in the use of RFIDs (Radio frequency Identification) and Wireless Sensor Networks. The drawback of this model is the reliance of these systems on centralized systems, which are not tamper-proof and not necessarily auditable (M. Armbrust, A. Fox, R. Griffith et a, 2010). For food traceability and verification to be efficient, a recording system that is trustworthy, reliable, and not prone to modifications that may encourage food fraud is required. The use of the current traceability systems such as RFID and Wireless Sensor Networks are quite widespread amongst higher-level stakeholders such as the wholesalers and retail markets. Most consumers lack access to this technology as they are quite complicated and are better suited for the stakeholders who need them for tasks such as stock inventory and reducing theft in the stores. Filling the need for a consumer-centric approach to food traceability and verification is undoubtedly one that would revolutionize the food sector.

6. Blockchain and Food Verification

The use of blockchain in food is becoming quite popular with higher-level agricultural technology enthusiasts.

A perfect food supply chain should be;

- Traceable
- Maintain the safety and quality of food products
- Ensure adequate and verifiable communication within the parties involved, including final consumers'
- Minimize supply chain cost to make food affordable
- Track and control inventory in warehouses and stores.

With the aid of blockchain and IoT, consumers and even retailers can ensure that their food is safe and has gone through an ideal supply chain. Wageningen University and Research Institute in the Netherlands have applied the BCT to manage the certification of grapes more efficiently. In the US, Walmart, in collaboration with IBM, is using blockchain to track food safety of leafy vegetables sold in its stores. **Fairfood** in the Netherlands, in collaboration with Wageningen, has an intensive use of blockchain in food with various case studies in the Nutmeg, Coffee, and Coconut value chains. These case studies are using BCT to provide a consumer-centric approach to food safety verification, and traceability thus empowering customers to verify food for themselves and make their decision. Blockchain technology provides consumers with the ability to go beyond certification to verification. As opposed to having one or several central certification bodies to safeguard and control claims such as credence attributes and food safety indices, BCT provides the ability to verify claims related to a specific product batch directly from the source down to the shelves. With the aid of digital passports such as barcodes, QR Codes, etc, consumers can verify claims of food labels and make decisions without any doubts. The image below shows the framework of this process.

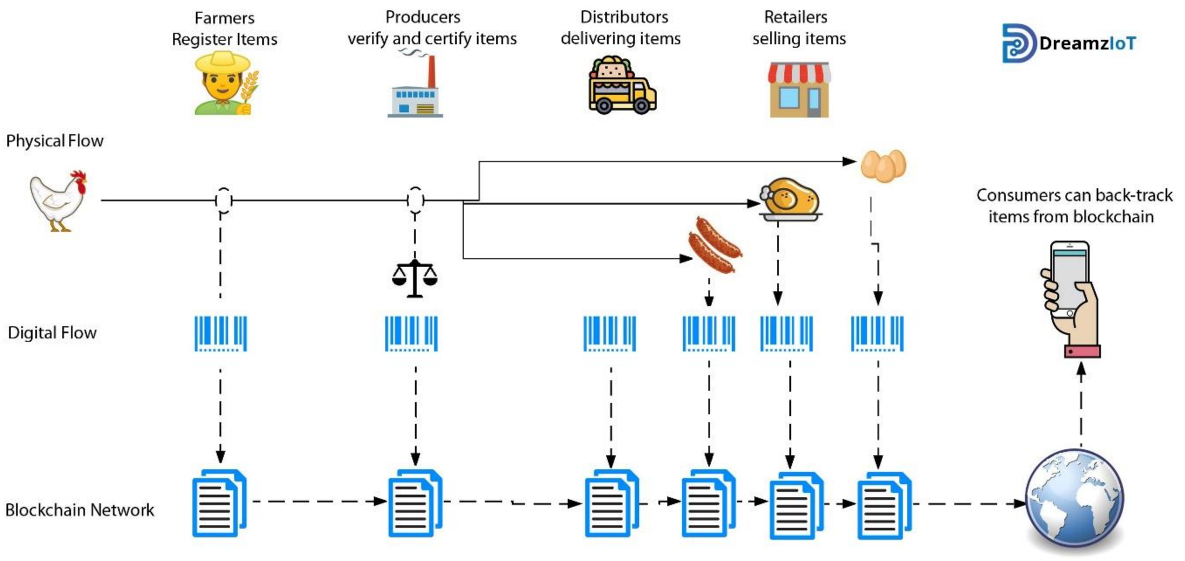

Image 1: showing the movements along the food value chain as they are recorded
Source: DreamzIOT, 2018

The combined utilization of blockchain and the Internet of things poses a promising solution to global food fraud and traceability crisis. Fairfood reports in its position paper on that four essential elements are useful in verifying claims. They are as follows.

The claim, which is the claim made by the company about their product;

The Criteria; this is the criteria that need to be met in order to prove the claim, e.g., minimum price given to farmers per kg, pesticide usage load per ton, etc.

The authority refers to the organization that has the authority to verify the claim and.

The proof: which is the proof that needs to be delivered by the authority to verify the claim.

Once information about a food product is logged on the blockchain, it goes into unalterable blocks that trace the entire path the product goes through from farm to fork. When BCT is being used in food supply chains, it is essential to note that they are only as trustworthy as the data entered into them. To prevent unreliable data from getting into the blocks, a third party might still be needed to verify the data.

7. Conclusion

Blockchain's unique features, which make it genuinely democratic, offer value chain actors the opportunity to upload verified information on the details of their work in the supply chain. Presently, BCT is the only technology that allows for 100 % self-reporting at every single stage of the supply chain, eliminating the need for an external third party or a central ICT system to store the sensitive information and risk the possibility of the information's alterations. Given the fact that agricultural value chains are quite scattered and the high level of distrust amongst value chain actors in Agricultural value chains, this technology poses a huge potential to solve the problem of food fraud

The combination of blockchains, mobile phones, and the appropriate digital passports presents a unique opportunity to make agricultural value chains more transparent, efficient, and inclusive of the essential stakeholders in the value-chains- the consumers. Blockchain technology possesses the capacity to revolutionalize the way the food system works and empower consumers with the tools to ensure food safety and influence consumer choices.

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