The Economics Behind Food Supply Blockchains

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Abstract:

The use of blockchain in food and beverage supply chains may offer benefits by improving food safety, supplier reputation, the visibility of small farmers, efficiency in tracing food contamination sources, transparency, and accountability.

Keywords: beverages | contamination | food processing industry | food safety | blockchain | developing countries | supply chains | food products | intelligent systems | autonomous systems

Article:

Approximately 600 million people in the world become ill due to contaminated food each year. Of those, about 420,000 die, a number that includes 125,000 children younger than five years old.[1] Tracing food and beverage supply chains (FBSCs) using blockchain might offer help. The storage of FBSC information using blockchain has the potential to improve some of the following: food safety, food and beverage supplier reputation, fairness and visibility of small farmers, efficiency in the process of tracing food contamination sources, transparency, and accountability.

FBSCs in Developing Countries

Blockchain deployment in FBSCs in developing countries is driven by diverse forces, motivations, and rationales. First, to understand the blockchain-led changes in FBSCs in developing countries, this technology's deployments in FBSCs can be plotted on a two-by-two matrix (Table 1) that illustrates the origination of products (on the horizontal axis) against the location of consumers (on the vertical axis). Blockchain solutions in each cell in Table 1 have unique features that can affect different stakeholders and help achieve the different objectives of FBSCs.

Table 1. A two-by-two matrix classifying blockchain use in FBSCs in terms of the geographies of the companies deploying the solutions and target consumers.

Origination of products → Location of consumers ↓	**Developing countries**	**Developed countries**
Developing countries	1 • Carrefour in Brazil, France, and Spain • Walmart tracking pork products in Chinese stores	3 • Nestlé's pilot project to track milk from New Zealand to the Middle East • JD.com allowing customers to track high-end beef from Australia
Developed countries	2 • Walmart monitoring produce imported to the United States from Latin America • Bext360 tracking coffee exported from Uganda and Ethiopia to the United States and The Netherlands	4 • Walmart in the United States requiring suppliers of leafy green vegetables to use blockchain • Carrefour enabling QR-codes to track milk products in Spain, France, and other developed countries

The first example in Table 1 (cell 1) involves the use of IBM's blockchain-based Food Trust, which creates permanent food system record data that are shared among FBSC participants.[2] Companies can join the network for a subscription fee, which ranges from US$100 to US$10,000 a month.[3] The French retailer Carrefour signed an agreement with IBM to use this solution. The retailer announced a plan to track its own branded products in France, Spain, and Brazil and expand to other countries by 2022.[7] Likewise, in 2016, Walmart trial-tested a blockchain-based solution to monitor pork products in China and produce imported to the United States from Latin America. The information tracked includes the farm where the vegetable or meat originated and its operating practices. Radio-frequency identification tags, sensors, barcodes, and other sources provide relevant data.[4]

Blockchain is being deployed within domestic FBSCs in developing economies, such as Brazil and China.[5] Walmart's Chinese trial took place in a farm operated by a company called Jinluo located in the northeastern city of Lingyi. Jinluo provided data about its pork products, such as the farm inspection report and livestock quarantine certificates.[10] These data were uploaded to Walmart's blockchain in real time. Data related to products, farms, factories, batch number, storage temperature, and shipping as well as files related to farm inspection reports and the livestock quarantine certificates were also secured with the blockchain. This information is stored by Walmart, which employed the Hyperledger platform to build the system.[11]

Walmart China commercially launched its Blockchain Traceability Platform in June 2019. At that time, 23 product lines sold in China used the platform, and that was expected to increase to 100 by the end of 2019. Walmart aims to have 50% of packaged fresh meats and vegetables and 12.5% of all seafood sales tracked on the platform by the end of 2020.[6] The company trained about 100,000 employees and suppliers to use the platform. The goal is to make sure that enterprises or consumers can use the system without additional costs.[7]

As illustrated in cell 2 of Table 1, blockchains have been developed to track food and beverage products exported from developing to developed economies. For instance, Colorado-based startup Bext360's kiosks in Uganda evaluate coffee beans using its Bextmachines. These are Coinstar-like devices fitted with machine vision, artificial intelligence, the Internet of Things,

and blockchain. Bextmachines analyze farmers' coffee cherries and coffee parchment deposited at collection stations and sort them to assess quality. Farmers who supply bigger and riper cherries are paid more. Bext360's systems store data related to the time, date, and location of transactions as well as the amount of payment.

The Bextmachines link the output to cryptotokens that represent the coffee's value. New tokens are automatically created when a product passes through the supply chain. The value of the tokens increases at each successive stage in the supply chain.[12]

By using a mobile app, suppliers and customers can hopefully negotiate fairer prices.[13] Also, farmers get paid immediately, and the app also identifies sellers. Using Bext360's application programming interface, intermediaries, such as wholesalers and retailers, embed the technology into their websites, marketing, and point of sale systems.

Blockchains have been deployed in FBSCs in developing countries to track imports of food and beverage products from developed countries (Table 1, cell 3). Such products are mainly targeted at wealthier consumers. Alibaba teamed up with New Zealand dairy product maker Fonterra and New Zealand Post to track products imported into China from New Zealand. It also collaborated with Australian health-care supply firm Blackmores and Australia Post to develop the blockchain-based Food Trust Framework.[14] The goal is to develop a blockchain model that all participants across the FBSCs can adopt.

Tmall uses blockchain and product tagging with a unique QR code assigned to each product. Imported food products are tracked and monitored, and relevant information is made available to consumers. Each step in the supply chain is authenticated and verified. Relevant data, such as production, transportation, customs, inspection, and transfer of ownership, are secured with the blockchain. The blockchain evidence is stored by Alibaba. Copies of the records are also stored and validated by other participants.[15]

In 2019, Nestlé announced a pilot project to allow consumers to track food products from the farm using the open blockchain platform OpenSC, which allows anyone to access independently verifiable sustainability data on FBSCs. The plan here is to trace milk products from New Zealand farms to warehouses and factories in the Middle East.[16] Finally, indirect effects on FBSCs in developing countries can result when more developed companies use blockchains to track products originating from, and targeted at, developed countries if these companies also operate in developing countries (Table 1, cell 4).

FBSCs: Benefits and Opportunities

Blockchain deployment in FBSCs can bring benefits and opportunities for businesses, consumers, and the economies of developing countries.

Strengthening food safety programs

Blockchain systems have the potential to strengthen national food safety programs. For instance, food items, such as milk, meat, rice, and vegetables, may be tainted.

Enhancing corporate reputation

Examples of successful food traceability systems implemented in developing countries indicate that such systems pay handsomely. For instance, in 2014, Uruguay implemented a fully computerized traceability system to track beef products. The system allowed consumers to know the origination of their beef and how the animals were raised. The Uruguayan government spent US$70 million to set up their system, allowing Uruguay to gain a reputation one of the world's foremost producers of quality beef. It exported beef products valued at more than US$1.6 billion in 2015.[17]

Distributive fairness and transparency

The deployment of blockchains in FBSCs can lead to a higher degree of fairness in the distribution of profits. For instance, coffee farmers have complained that roasters sell processed coffee at high prices and that the payment producers receive is reduced each year.[18] Blockchains, such as those of Bext360, have the potential to enhance fairness.

Farmers can also learn specific ways in which they can play a more important role in the value creation process. For instance, in the Bext360's case, each coffee bean is provided a unique ID, which can be used to track it throughout the life cycle.[19] Wholesalers and roasters can discover attributes that produce certain tastes, and they can make future sourcing decisions based on this. In addition, farmers can focus their efforts on growing the types of coffee beans that are valued more by consumers.

Efficiency

Blockchains may bring efficiency and improve supply chain processes. In a crisis involving contaminated food products, retailers, such as Walmart, can easily identify the source and remove the affected products. Thus, they may not need to recall an entire product line. Blockchains also enable a more effective response if tainted products are discovered and have important cost-saving implications for retailers.

There have been some encouraging developments to address the challenges described. In Walmart's trial of a solution to monitor pork products in China, blockchain was used to digitally track individual pork products in a few minutes, a process that took many days without it. Information about the farm, factory, batch number, storage temperature, and shipping can be more easily accessed. Such details help assess the authenticity of products. In the case of food contamination, it is possible to pinpoint the products to be recalled.[20]

FBSCs: Deployment Challenges

Challenges exist in the adoption of blockchain in FBSCs. Some barriers negatively affect small-holder farmers' and farm workers' capabilities to take advantage of the technology. We now mention a few of these.

Lack of skill and absorptive capacity

Developing countries may lack adequate capacity to benefit from blockchain applications due to a lack of competence, skills, infrastructures, and institutions. As mentioned, Walmart needed to train employees and suppliers to use its blockchain platform in China. In addition, smaller countries may not be attractive for multinational companies, such as Walmart, to implement blockchains and train employees and suppliers.

Infrastructure, market, and technical challenges

Low levels of economic activities in developing countries are associated with thin markets, where there are few buyers, sellers, and transactions in which blockchain applications can be applied. Additional challenges include high transaction expenses and high unit costs in the development of technological and physical infrastructures.[8] Due to these factors, being involved in a blockchain that was created by a larger organization might involve significant costs and efforts for small suppliers and farmers.

Small businesses

Like other technologies, blockchain deployment tends to diffuse from larger to smaller organizations. This is commonly known as the *rank effect*.[9] Due to cost and complexity, blockchains are expensive to implement and manage. For this reason, they may be out of reach for many. Most food products from developing economies are produced on small farms that lack access to Internet connectivity. Therefore, many small farms may not have the capability to adopt blockchains into their processes.

Low-value food products

Due to cost and complexity, it is not currently practical to implement blockchain for low-cost food products. Companies may opt to limit blockchain deployment to higher-value food products. For instance, Carrefour's traceability project focused on its premium farm products.[21]

There appear to be many benefits of using blockchains in FBSCs to all segments of the world's population. Wealthier consumers will have access to safer and more sustainable food and beverage products. There is also hope that blockchain might ensure a fairer and living wage for smaller farmers and suppliers.

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