BLOCKCHAIN FOR ORGANIC FOOD TRACEABILITY: ANALYZING CASE STUDIES ON DRIVERS AND CHALLENGES

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ABSTRACT: The goal of this study is to look into how European regulations could be changed to make use of blockchain technology to make tracing organic or fair-trade agricultural products easier. The goal of this research is to identify the present difficulties facing the organic food supply chain, the drivers driving blockchain technology adoption, and the obstacles inhibiting success. The feasibility of four blockchain-based projects was examined using a case study technique in this study.

Companies in the organic food supply chain who want to use blockchain technology to improve food tracking must pick between two possible options. Two potential answers are making it easier for chain users to communicate with one another and defining what data needs to be stored on the blockchain. The organic supply chain's details are important to their success. As a result, sharing data, authenticating user input, and keeping personal information safe all become issues. Among the benefits are increased responsibility, improved risk management, a better grasp of the company's inner workings, faster information sharing and gathering, and clearer lines of communication. It is also easier to verify certifications in the database. Many organizations could benefit from whole-chain tracking, but blockchain technology is unneeded in this case. Blockchain technology may aid complex food distribution networks by speeding up the tracking of food goods. Our research has limitations due to a lack of organic blockchain projects aiming to reduce the need for pesticides and a paucity of data relevant to commerce in this area.

Implications for Practice This study shows, albeit on a small scale, how blockchain technology can be used to track the whole supply chain of organic and fair-trade food. The primary goal of this study is to see if there is a link between the position in the food distribution chain and the quality and certification of organic foods. More research on food-tracking regulations in the European Union is needed, and the importance of organic data elements and the emphasis on origin data can serve as a starting point for that research. The findings of this study will help us better grasp the current state of blockchain.

Keywords:traceability,blockchain,organic,agrifood,foodsupplychain,interoperability,certifications,fairtrade

1. INTRODUCTION

The goal of this study is to look into how European requirements can be met while using blockchain technology to track organic or fair-trade items along the supply chain. The fundamental goal of this research is to provide light on the organic food supply chain's issues, the motives for integrating blockchain technology, and the limitations of current attempts. The feasibility of four blockchain-based projects was examined using a case study technique in this study.

Businesses in the organic food supply chain who want to use blockchain technology to improve food tracking have two options. You can optimize the paths that messages take between nodes in the chain and decide which data should be stored in the blockchain itself. Without its unique components, the organic supply chain cannot function. As a result, sharing data, authenticating user input, and keeping personal information safe all become issues. Among the benefits are increased responsibility, improved risk management, a better grasp of the company's inner workings, faster information sharing and gathering, and clearer lines of communication. It is also easier to verify certifications in the database. Many organizations could benefit from whole-chain tracking, but blockchain technology is unneeded in this case. Because it helps speed up the process of tracking food, blockchain technology is thought to be a good fit for sophisticated food delivery networks. Our research has limitations since there aren't many organic blockchain projects whose only objective is to reduce reliance on pesticides, and because there isn't much data on linked commercial activity.

The practical ramifications of the study are important. This pilot study demonstrates the viability of using blockchain technology to track the whole organic and fair-trade food supply chain. This study focuses on the connection between the food supply chain and the quality and certification of organic products. More research on food-tracking regulations in the European Union is needed, and the importance of organic data elements and the emphasis on origin data can serve as a starting point for that research. The findings of this study would strengthen current hypotheses regarding how blockchains work.

2. THEORETICAL BACKGROUND

The study articles include a wide range of topics that highlight how blockchain technology can change the ability to track food. According to Moe (1998), a traceability system should be broken down into modular components that can be coupled in numerous ways to provide variable degrees of information. Opara's (2003) study has more information on the concept of monitoring and tracing, which is critical for guaranteeing that all portions of supply chains can be followed. The research of Aung and Chang (2014) illustrates how complex the food traceability system is. This research is valuable for those who seek to understand more about tracking systems in the supply chain. These concepts affect the distribution network for natural and organic commodities. This section describes blockchain technology and its possible applications in the organic food supply chain.

Traceability Systems

The skeleton of a tracking system, as described by Moe in his 1998 work, is represented in Figure. A full list of fundamental entities, encompassing both actions and outputs, was compiled by Kim et al. in 1995. This inventory was updated by adding essential descriptors that are required for best traceability. The depth of a provenance system is governed by the quantity and types of subdescriptors the user picks (Moe, 1998).

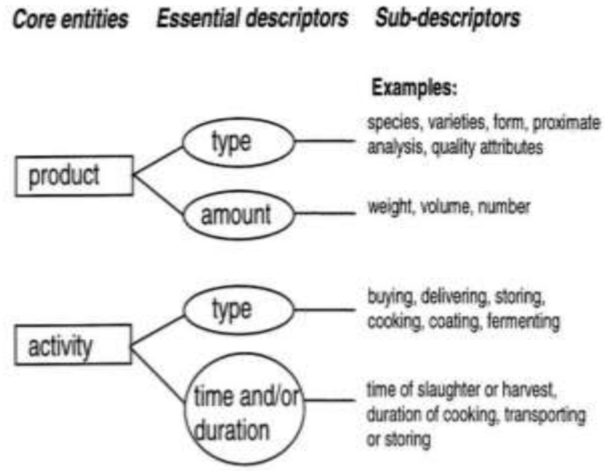

FIGURE1|Fundamentalstructureofatraceabilitysystem.

According to Opara (2003), maintaining the capacity to keep tabs on products is vital for keeping eyes on agricultural quality. Finding, verifying, and detecting instances of deviance from set standards and consumer expectations is substantially easier by traceability. The methods used to identify and verify organic items are reviewed, as are consumer purchases of non-organic foods that do not correspond to certification or regulatory criteria. The aforementioned item supports the translation of Moe's (1998) basic design into Opara's (2003) preventative traceability system suggestion. With this strategy, you may trace actions all the way back to their originator and forward them to selected people. Temperature-controlled refrigerated units (TRUs) and their component parts are the focus of study by Olsen and Borit (2018) and Opara (2003). Traceability Reference Units (TRUs) are described in a study by Kim et al. (1995). In the field of research, it is vital to consider the granularity of product monitoring. When items are exchanged out in the food supply chain, traceability codes and temperature recording units (TRUs) often have one-to-many links. But most people consider that it's ideal to make direct relationships between each of these parts. The most significant components of lineage systems, as well as their implementation, have been outlined by Olsen and Borit (2018).

Aung and Chang (2014) evaluated the flow and exchange of traceability data in the global food supply chain. The effects of their efforts are represented in Figure 2. Aung and Chang (2014) remark that monitoring all connections in the supply chain is a priority for them. The product provenance information system, quality assurance, and legal considerations make up the three key components of the methodology.

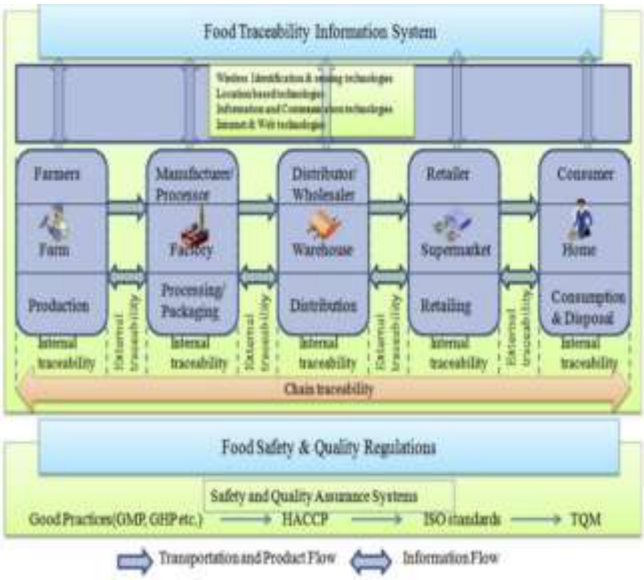

FIGURE2|Generalframeworkofafoodtraceabilitysystem.

The methods of developing software adopted by Lindvall and Sandahl's (1996) research involve an equal number of vertical and horizontal lines. Wognum et al. (2011) classify the many methods in which individuals try to comprehend traceability into the "vertical" and "horizontal" categories, respectively. The vertical axis depicts the various laws pertaining to tracking, while the horizontal axis depicts the various laws pertaining to information sharing.

3.RESEARCH METHODOLOGY

The research employed a multiple-case study design, with data collected via in-depth interviews and a review of publicly available project documentation. Here, we discuss the methodology behind our four case studies, including how we selected them, where the data came from, and how we examined it.

Multiple-CaseStudy

Eisenhardt (1989), Benbasat et al. (1987), and Yin (2018) are just a few of the researchers who have employed case studies to examine contemporary events in their original contexts. This research focuses on certifying groups in Europe's organic food supply chain to see how they are impacted by blockchain technology. Multiple case study is the research strategy being employed. This methodology allows for the investigation of specific occurrences within their respective contexts. Researchers can examine and contrast the similarities and differences between various cases with the use of multiple case studies. Consistent outcomes in several cases can be predicted with greater ease in this way.

External Validity

Focusing on origin traceability, particularly within the scope of organic and fair trade rules, was stated to have the same results by Benbasat et al. (1987) and Yin (2018). The findings were evaluated in a variety of contexts to ensure their generalizability, including with organic and fair-trade items and supply chains of varying sizes. There won't be a lot of variation, for instance, between how one large supermarket and another handles the food supply chain.

Internal Validity

According to European Union regulations, determining which specific data items are needed for organic food monitoring requires an analysis of case-specific traceability data. To demonstrate the reliability of the constructs, the study employed "data triangulation," which entails gathering confirmation from three distinct sources, such as in-depth interviews, literature reviews, and case studies. The study's internal validity was ensured by the use of case-based pattern matching and explanatory modeling, as well as results recorded in Atlas.ti and a set of reports and notes (Yin, 2018). Moreover, the scenarios were evaluated with the help of logic models developed with publicly available information.

Reliability

Readings were utilized to form opinions about what was happening. As an illustration, in each scenario, a single, semi-structured interview was conducted in Dutch using a framework that includes several various sorts of traceability issues and concerns. This allowed for thorough examination of cases and analysis of collected data. Business and IT professionals were polled on their familiarity with technical vocabulary and product tracking methods. A great deal of detail is provided, making it simple to replicate the case study in its entirety.

Selected Cases

After doing a thorough literature review and web search, we identified 34 blockchain application cases across a wide variety of businesses, both in Europe and outside of it. Eleven companies from the organic and fair trade industries were included in the research. They picked five of them at random. The primary criteria utilized to select them were their level of participation, the quality of their documentation, and the availability of a contact person for the project. By requiring candidates to provide at least five concrete instances, the inclusion of fair trade practices mitigated the risk of candidates becoming disengaged throughout the interview process. Multiple methods were used to assess four blockchain projects, including document analysis, user interviews, and solution presentations. Careful selection of cases is utilized to demonstrate consistency or variation in multiple-case studies (Yin, 2018). By analyzing both successful and unsuccessful blockchain food monitoring projects, this research aims to identify the barriers that prevent individuals from adopting this technology.

4. ORGANIC TRACEABILITY

The impact on the organic food supply chain in Europe is outlined in Table 7 of Organic Food Traceability: Types and Issues. Since blockchain technology relies on transactional data and EU regulations don't mandate the inclusion of biological data, certain data were examined to determine how readily they might be monitored. There was data collection for all three events in the case study. In cases 1, 2, and 3, however, the certification data was not simply linked to the certificate but was instead stored on the blockchain. Since its certification, the blockchain system has failed to record four times how much pesticide was absorbed. In addition, all blockchain initiatives receive data from vouching bodies. TPC examined not only paperwork from farms and agricultural groups, but also information about the origins of the food in Case 2. When it comes to making sure farmers and fishermen get paid fairly, Cases 1, 2, and 4 leverage blockchain technology to verify trader payments at the source. A smartphone software streamlines the process of sending out text message confirmations of sales in the nutmeg growing industry. There is no such thing as fraud because there is no means to verify honest dealings. Another potential issue is the unpredictability of blockchain data approval. To ensure that all parties in the supply chain are aware of a product's ownership, transactional and origin data must be visible to all participants. Research on the blockchain hasn't always been completely forthright.

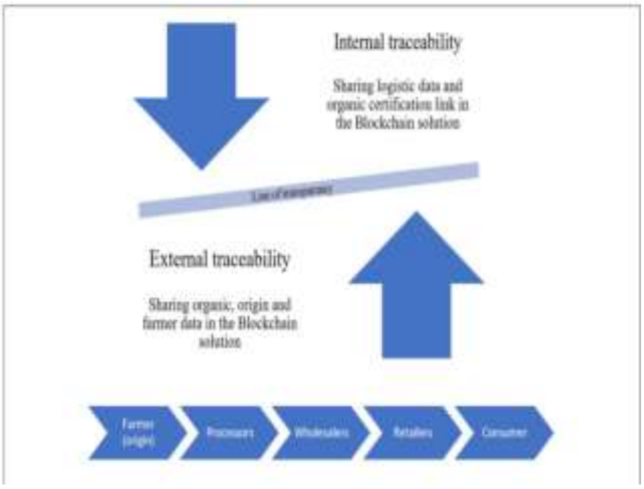

FIGURE3|Datasharingasthelineoftransparencyfor organicfoodinformation.

Maintaining secrecy was crucial during the operation. Initially, manufacturers, traders, and importers all along the supply chain concealed information out of concern for their competitive standing. Important business negotiations could be jeopardized if the exact coordinates of a location leaked. Using data regarding monetary ranges or geographical locations, this issue was resolved. Another observation was how the preferred blockchain data source varied greatly from one scenario to the next. There were certificates with references, and there were certifications with specific information about the grower and the origin of the goods. The length of time one can go back in a chain is proportional to the amount of information communicated between its members. The fact that the chain's participants have cooperated in various ways demonstrates the presence of trust. In all three cases, one organization is responsible for overseeing the initial stages of the supply chain. This organization might get materials from nearby farms and produce items in-house. It was simple to launch the initiative, decide how to distribute data, and guarantee its portability between platforms. Information regarding the farmers and fishermen involved in Cases 1 and 2 was provided. However, since both the third and fourth cases took place in expansive rice and citrus fruit fields, the farmers' combined efforts were ultimately ineffective.

5. CONCLUSION

By facilitating the finding of supply chains and the accumulation of relevant data, blockchain technology enhances organic food's traceability. It also equips executives in charge of the supply chain with the knowledge they need to use the organic chain's qualities to their advantage when making decisions. The reply was negative. Blockchain technology isn't required for more efficient supply chain tracking. Technology, NGO warnings, food-related events, and increased consumer demand have all contributed to this. Tracking food through intricate supply chains is made simpler and quicker with the use of blockchain technology. Sensors or sample testing were deemed too costly to determine a food's origin. These measures may be more reliable than TPC periodic sampling for performing preliminary checks on the origins of organic food supply lines. With these resources, it may be able to develop software at a lower cost. Sharing information and establishing guidelines and standards could provide light on the origin of these programs. The amount paid to farmers and the types and quantities of pesticides used should be recorded and kept in a database. One advantage of implementing blockchain technology into networks that provide organic food is that it reduces the number of certification bodies required. Completely revamping the licensing system is quite unlikely.

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