Blockchain for Sustainability: Pioneering traceability in the Agri-food Sector

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Introduction

Blockchain Technology (BCT) has emerged as a focal point of modern technological discourse, attracting significant attention for its potential to revolutionize various industries. While many praise the virtues of BCT, a comprehensive understanding of its applications and implications remains limited. The academic and public debates oscillate between skepticism, viewing blockchain as overhyped and unproven, and optimism, with experts predicting profound societal and economic impacts soon. In the agri-food sector, BCT promises to enhance transparency, verifiability, and immutability of data, thereby ensuring traceability and authenticity of supply chain products (Ge *et al*, 2017; Gartner, 2019). This capability extends to automating supply chain management and quality control through smart contracts. Despite the growing number of use cases during the last decade, the full potential of BCT in the agri-food domain remains largely untapped, both in the private and public sectors (Saurabh and Dey, 2021; Kamilaris *et al*, 2019). The rapid and unpredictable evolution of blockchain innovation, coupled with its context-specific application and the surrounding hype, poses challenges for strategic decision-making, especially for government agencies.

Material and Methods

The project is structured into several key tasks which include the creation of a comprehensive database of existing blockchain applications within the agri-food domain. This task focuses on assessing their operational frameworks, technology stacks, and use-case efficacy, providing a detailed report that maps the current state of blockchain technologies in agri-food chains. Another major task is the establishment of a robust network of agri-food stakeholders including producers, technology providers, and regulatory bodies. This network aims to foster dialogue and gather insights on the barriers and facilitators to blockchain adoption, with the deliverable being the creation of working groups and forums that facilitate continuous stakeholder engagement. Furthermore, the project involves analyzing and creating new business models that leverage blockchain to enhance transparency and efficiency in agri-food supply chains. A detailed analysis of these models and a cost-benefit analysis based on pilot implementations will give insights to the use of BCT. Additionally, the project involves the development and testing of specific blockchain frameworks tailored to the needs of the agri-food sector, focusing on scalability, interoperability, and user-friendliness, with pilots deployed in selected case studies to assess their impact. Finally, ensuring all blockchain solutions developed are compliant with existing and forthcoming regulations is crucial, with deliverables including guidelines and best practices for BCT implementation that align with national and international regulations.

The research methodology is employed across three White Papers implying a triangulated approach, combining findings from various sources, including academic research, industry reports, and expert interviews. Each paper follows a structured analysis involving Standards in Blockchain, Interoperability with Legacy IT, as well as Skills Development.

Results and Discussion

The initial findings from the TRUSTyFOOD project indicate significant potential for blockchain technology to enhance traceability and transparency in agri-food supply chains. The deployment of

blockchain frameworks has demonstrated increased data reliability and operational transparency, which are crucial for effective supply chain management. One of the key results observed is the enhanced ability of blockchain to provide real-time data traceability and transparency across various stages of the agri-food supply chain. This capability allows for better monitoring of food quality, origin, and safety, facilitating quicker responses to food safety incidents and reducing instances of food fraud. The blockchain's immutable ledger ensures that all data entries are permanent and tamper-proof, increasing trust among consumers and regulatory bodies. BCT has also proved instrumental in improving compliance with regulatory requirements. The immutable and transparent nature of blockchain records simplifies the audit processes, making it easier for companies to adhere to complex food safety standards and regulations. This compliance is not only crucial for consumer safety but also enhances the market credibility of agri-food businesses.

Despite these advantages, several challenges have been identified during the implementation phase based compared to the findings of other studied (European Commission, 2019; Rana and Dwivedi, 2021). One significant issue is the integration of blockchain technology with existing IT infrastructures in the agri-food sector, which often requires substantial initial investment and training. Additionally, the scalability of blockchain solutions poses a challenge, as the technology needs to handle large volumes of data generated by modern agri-food supply chains without compromising performance. Another critical area of discussion revolves around stakeholder acceptance. Looking forward, the TRUSTyFOOD project aims to address these challenges by refining blockchain applications to enhance user-friendliness and reduce costs associated with technology adoption. Future research will focus on developing more scalable blockchain solutions that can be seamlessly integrated with existing technologies.

Conclusions

The TRUSTyFOOD project highlights the transformative potential of blockchain technology in revolutionizing waste management practices within the agri-food sector. By improving data reliability and process transparency, BCT enables more sustainable practices and contributes to the broader goals of the circular economy. Future research will focus on overcoming existing barriers to adoption and enhancing technology acceptance among key stakeholders.

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