BLOCKCHAIN APPLICABILITY IN FOOD TRACEABILITY SYSTEMS

1 INTRODUCTION

The consumers of the current society are increasing their sensitivity and awareness about aspects related to food quality and safety due to diverse occurrences of events related to public health and food contamination with global impact(PIGINI; CONTI, 2017).

In this scenario, concerns about food safety are based on a number of contamination risk factors, such as agrochemicals, veterinary drugs, packaging and transportation (ERGÖNÜL, 2013).

These factors have led to a great interest in the development of information systems for food traceability, guaranteeing transparency to the final consumer and reducing information asymmetry (STOROY; THAKUR; OLSEN, 2013).

However, systems based on consolidated technologies may present weaknesses, due to the centralization of the information and data involved in control of a third party and not in the agents involved in the transaction (YLI-HUUMO et al., 2016).

In this sense, the objective of this work is to analyze the possible applicability of blockchain technology in food traceability systems and its contribution to increase consumer confidence.

Blockchain, or Blockchain technology as can be referred to, is a distributed encrypted system that capture and storage a linear, immutable and nonperishable record of transactions between agents in a chain (NAKAMOTO, 2008; RISIUS; SPOHRER, 2017).

2 METHOD

This work is based on the method of Qualitative Comparative Analysis (QCA) presented by Ragin (1987), using for data analysis available data in relevant academic publications.

The more traditional approach of the QCA is adopted, considering the low volume of information for analysis of the application of blockchain in the universe of food traceability systems. The analysis is based on the contraposition of the requirements of a traceability system and the attributes of blockchain.

The focus is on the preservation of the richness of the information about the identified attributes of the study object, preserving the qualitative characteristic of the work and allowing the comparison with another universe of attributes (RIHOUX, 2006)

3 RESULTS

Considering the similarity and complementarity delineated by the positions of (HU et al., 2013; PIGINI; CONTI, 2017; STOROY; THAKUR; OLSEN, 2013; TARJAN et al., 2014) this paper adopted the parameters presented by Pigini e Conti (2017) as a basis for correlation between attributes of blockchain and requirements of traceability systems.

The set of attributes and applicability's that make Blockchain attractive and possibly applicable to food traceability are highlighted in Table 1 as a result of the application of the QCA.

Table 1: Requirements of a traceability system and blockchain attributes

Food Tracebiality System Requirements	**Description***	**Blockchain technology attributes****	**Reference in the literature ****
Food Safety Control	Fast tracking back and forward of the supply chain in case of crisis management related to food contamination that may cause harm to consumer health.	By design the Blockchain network can allow public access to the data of the transactions, ensuring the fast analysis. The added encryption of the multiple records avoids undue changes in the information, allowing the attribution of responsibilities properly.	(BUTERIN, 2014; CZEPLUCH et al., 2016; KSHETRI, 2018; NAKAMOTO, 2008; ØLNES; UBACHT; JANSSEN, 2017)
Food quality control	Ability to monitor and control the weather, geo-referencing of the entire chain for quality assurance.	The added encryption of the multiple records avoids undue changes in the information, which maps each transaction and agent involved, the data to be imputed can contain all the information regarding the productive and logistic conditions of the food.	(BUTERIN, 2014; KSHETRI, 2017, 2018; LENG et al., 2018; NAKAMOTO, 2008)
Information security	Food authentication, fraud prevention and counterfeiting prevention.	The added encryption of the multiple records avoids undue changes in the information, which maps each transaction and agent involved. Changes in the original records would only be possible in a 51% attack, which demands very high computational power and makes it unfeasible.	(BUTERIN, 2014; CZEPLUCH et al., 2016; KSHETRI, 2017, 2018; LENG et al., 2018; NAKAMOTO, 2008; ØLNES; UBACHT; JANSSEN, 2017; RISIUS; SPOHRER, 2017)
Control of authorities (public)	Possibility of rapid and automatic control by the public authorities.	By design the Blockchain network can allow access to the data of the transactions of public form, ensuring the fast analysis. The added encryption of the multiple records avoids improper changes in the information, allowing the attribution of responsibilities properly, allowing audit trails and efficient performance of public inspection agencies.	(BUTERIN, 2014; CZEPLUCH et al., 2016; KSHETRI, 2018; NAKAMOTO, 2008; ØLNES; UBACHT; JANSSEN, 2017; YLI-HUUMO et al., 2016)
Stock optimization	Real-time location and identification of items in production and inventory. Increased supply chain and logistics efficiency. Speed and accuracy in inventory.	The added encryption of the multiple records avoids undue changes in the information, which maps each transaction and agent involved, the data to be imputed can contain all the information regarding the productive and logistic conditions of the food.	(BUTERIN, 2014; KSHETRI, 2017, 2018; LENG et al., 2018; NAKAMOTO, 2008)
Consumer Involvement	Increased interest in certified quality, ethical products, respect for the environment and sustainability of the food production chain. Use the internet and smartphones to choose which product to buy.	By design the Blockchain network can allow public access to transaction data, ensuring rapid analysis. The added encryption of the multiple records avoids undue changes in the information, allowing the attribution of responsibilities properly. Safe and transparent information with access granted to consumers can boost confidence in the product and traceability system.	(BUTERIN, 2014; CZEPLUCH et al., 2016; KSHETRI, 2017, 2018; LENG et al., 2018; NAKAMOTO, 2008; ØLNES; UBACHT; JANSSEN, 2017; RISIUS; SPOHRER, 2017; YLI-HUUMO et al., 2016)

Source: *Adapted from (PIGINI; CONTI, 2017) and ** the author.

4 CONCLUSIONS

Blockchain technology is an exponent in the current technological scenario, its application beyond crypto coins is in the initial phase of study and test, but has disruptive potential. Its applicability in food traceability systems can be verified after QCA performed in the referred literature, but deeper studies are required even in an experimental descriptive field.

5 REFERENCES

BUTERIN, V. A next-generation smart contract and decentralized application platform. **Etherum**, n. January, p. 1–36, 2014.

CZEPLUCH, S. et al. **BLOCKCHAIN – THE GATEWAY TO TRUST-FREE CRYPTOGRAPHIC TRANSACTIONS**. İstanbul,Turkey: Twenty-Fourth European Conference on Information Systems (ECIS), 2016

ERGÖNÜL, B. Consumer awareness and perception to food safety: A consumer analysis. **Food Control**, v. 32, n. 2, p. 461–471, 2013.

HU, J. et al. Modeling and implementation of the vegetable supply chain traceability system. **Food Control**, v. 30, n. 1, p. 341–353, 2013.

KSHETRI, N. Blockchain’s roles in strengthening cybersecurity and protecting privacy. **Telecommunications Policy**, v. 41, n. 10, p. 1027–1038, 2017.

KSHETRI, N. 1 Blockchain’s roles in meeting key supply chain management objectives. **International Journal of Information Management**, v. 39, n. June 2017, p. 80–89, 2018.

LENG, K. et al. Research on agricultural supply chain system with double chain architecture based on blockchain technology. **Future Generation Computer Systems**, v. 128, n. 6, p. 1230–1240, 2018.

NAKAMOTO, S. Bitcoin : A Peer-to-Peer Electronic Cash System. p. 1–9, 2008a.

ØLNES, S.; UBACHT, J.; JANSSEN, M. Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. **Government Information Quarterly**, v. 34, n. 3, p. 355–364, 2017.

PIGINI, D.; CONTI, M. NFC-Based Traceability in the Food Chain. **Sustainability**, v. 9, n. 10, p. 1910, 2017.

RAGIN, C. C. **The Comparative Method: Moving beyond Qualitative and Quantitative Strategies.** Berkeley, Los Angeles and London: University of California Press, 1987.

RIHOUX, B. Qualitative Comparative Analysis (QCA) and Related Systematic Comparative Methods: Recent Advances and Remaining Challenges for Social Science Research. **International Sociology**, v. 21, n. 5, p. 679–706, set. 2006.

RISIUS, M.; SPOHRER, K. A Blockchain Research Framework: What We (don’t) Know, Where We Go from Here, and How We Will Get There. **Business and Information Systems Engineering**, v. 59, n. 6, p. 385–409, 2017.

STOROY, J.; THAKUR, M.; OLSEN, P. The TraceFood Framework - Principles and guidelines for implementing traceability in food value chains. **Journal of Food Engineering**, v. 115, n. 1, p. 41–48, 2013.

TARJAN, L. et al. A readability analysis for QR code application in a traceability system. **Computers and Electronics in Agriculture**, v. 109, p. 1–11, 2014.

YLI-HUUMO, J. et al. Where is current research on Blockchain technology? - A systematic review. **PLoS ONE**, v. 11, n. 10, p. 1–27, 2016.

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