Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 200 (2022) 904–913

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd International Conference on Industry 4.0 and Smart Manufacturing

Blockchain Enabled Quality Management in Short Food Supply Chains

Patrick Burgess[a,b]*, Funlade Sunmola[b], Sigrid Wertheim-Heck[a,c]

[a] *Aeres University of Applied Sciences, The Netherlands*
[b] *University of Hertfordshire, United Kingdom*
[c] *Wageningen University, Wageningen, Netherlands*

Abstract

Food system (re)localisation involves moving food systems back to local areas and a result are the short food supply chains. Food system (re)localisation is occurring to offset the perceived negative impacts of global food systems. Short food supply chains may face challenges in terms of quality set at national and international levels. Short food supply chains will benefit from technologies that can be developed to meet specific requirements which can be significantly different from those in conventional level food supply chains. One such digital technology is blockchain. This paper aims to present a blockchain based quality management architecture developed for short food supply chains. Requirements for the blockchain architecture are based on existing literature on quality management in food supply chains, with an emphasis on the specifics of quality and re-localisation in short food supply chains. Also considered in the architecture are the characteristic features of blockchain, with some emphasis on trust management and smart contracts. The adoption considerations regarding the resulting architecture are highlighted. It is concluded that the architecture has features relevant to the short food supply chain that differs from conventional food supply chains. Future work regarding implementation and validation of the architecture developed is suggested.

Keywords: Supply Chain Quality Management; Requirements; (Re)Localised Food System, Digital Technology; Trust

1. Introduction

In the 1980s, the era of global systems had emerged from technological advances to enable competitive advantage, and create value driven supply chains [1]. Global production systems often utilise economies of scale, considering international processing and retailing companies, resulting in the rise of industry standards [1,2]. Today, the consumers' perception towards globalised food systems negative impact on sustainability drives the movement

* Corresponding author. Tel.: +31650557854
E-mail address: p.burgess@aeres.nl

1877-0509 © 2022 The Authors. Published by Elsevier B.V.

10.1016/j.procs.2022.01.288

towards food system (re)localisation. (Re)localisation considers alternative food movements, which offer substitutes to global food systems. However, many alternatives focus on small scale initiatives. The (re)localisation of food also reflects on the shift from conventional food supply chains towards short food supply chains as explained by [3,4]. The term 'local', or 'short', can be perceived differently amongst stakeholders. For example, [5] presents a case discussing a restaurant using ingredients from local producers and processors, however, second-tier suppliers source at a global level. The research by [5] discusses 'local by proximity', which limits the distance geographically or by political boundaries, and 'local by relationship' which focuses on the relationships in the supply chain. According to [6], a food supply chain takes food from a raw state, through a series of processes, actors, and activities to create value-added products for consumers. Essentially, a short food supply chain (SFSC) is one with fewer actors compared to a conventional one, in addition to reduced physical and social distance [7].

The main differences between the conventional food supply chain and SFSCs include the configuration of the chain, the relationships in the network, and the interest of supply chain stakeholders [8]. Three types of SFSC are identified in the literature [9]. Face-to-face, using direct sales between farmer and consumers. Proximate, through an intermediary, for example, a farm store, and extended, through certification schemes, such as geographical indication labelling. SFSCs aim to improve the three-bottom line of sustainability [3,10]. The three-bottom line focusing on economics (e.g. enhanced efficiency, improved customer satisfaction), environment (e.g. clean production and logistics) and social (e.g. ethics, human rights, employee well-being) [11]. In SFSCs, [12] discuss that upstream stakeholders are primarily driven economically. Recent trends show that social and environmental factors are increasingly sought for [13], thus driving the need for improved supply chain and quality management performance.

In principle, supply chain quality management is the coordination and integration of business processes, including all organisations in the supply chain, to control, evaluate, analyse, and improve outputs to create value addition for customers [14]. [15] noted the importance of communication throughout the entire food supply chain to manage food quality. Food quality is based on product requirements (sensory, safety, conformity), social requirements (ethics, production context), guarantee requirements (certificates, traceability), market requirements, and packaging/logistics requirements [16]. Food quality management in SFSCs differs comparing to large, globalised food supply chains. Examples of SFSC quality considerations include geographical indications, health, freshness, and authenticity [17,18]. There are indications in the literature that there is limited insight in respect to quality management within alternative food systems and SFSCs [19]. Quality management systems in long supply chains are well structured and based on global standards. Instead, quality in SFSCs is often socially constructed, representing the 'Laisses-faire' quality management style [20]. As in all food systems, SFSCs should comply with government and organisational standards where adopted, however may not always be accounted for.

Quality Management in SFSCs would benefit from advances in digital technology. Examples of digital technologies in food supply chains are increasing and they include innovative informational platforms [21–26], blockchain technologies [27–29], IoT and sensor embedded systems [39,74,77,80], artificial intelligence, and big data technologies [27,31]. Digital technologies in alternative food systems are present [24]. However, [24] mentions that current platforms often provide little information on quality, certifications, and production methods. Digital platforms for SFSCs, are far from developed regarding quality management.

The need for quality in re-localised food systems [32] could be enabled by digital transformation [11]. Blockchain is one of the enabling technologies. Existing literature shows the benefits of blockchain based quality, traceability, and trust supporting frameworks [33–35]. Within the food supply chain literature, existing work offers insight into blockchain architectures e.g. for safety, sustainability, traceability [36–38]. These architectures are based on the needs of specific supply chain structures and types [39]. In respect to food quality management, existing architectures offer novel applications and benefits for food systems, however, missing is a blockchain architecture that encompasses the requirements for SFSC quality management within re-localised systems. This paper aims to develop a blockchain architecture for short food supply chain quality management based on the key requirements of SFSCs.

The remainder of this paper is in five sections. Section 2 contains a literature review on re-localisation and quality management in SFSCs. Also contained in Section 2 is an overview of blockchain technologies in food supply chains. Section 3 presents the research method used in this work. The requirements for blockchain based quality management in short food supply chains are highlighted in Section 4 and the proposed blockchain architecture and its discussion is contained in Section 5. Section 6 concludes the research and proposes areas for future work.

2. Literature Review

2.1. Quality and Re-localisation in Short Food Supply Chain

(Re)localised food systems are increasingly sought for in respect to consumer perceived quality and sustainability benefits reflecting on the notion of 'quality turn' [40,41]. The 'quality turn' refers to consumer demand for a better understanding of the quality aspects of food and where it comes from [42]. [43] discusses three central questions concerning food re-localisation. The questions relating to the assumption of positive impacts, the achievability rate of (re)localisation, and how to realise re-localised systems while barriers are present. [44] identified four contextual elements, namely history, proximity, scale, and reach. SFSCs can include various stakeholders, however, the emphasis is on relationships, and reduced intermediaries [45–47].

Food supply chain quality management is the holistic set of tools and principles that drive continuous improvement [48]. Key quality management practices for food supply chains are identified in [49] and include supplier management, human resource management, quality of information and related systems, supply chain integration, customer focus, internal quality, and top-management support. Internal and external quality considerations are important. Internal quality reflecting on the manufacturing, operations, and management within an organisation [50]. While the external focus on quality throughout the supply chains. Quality management as an input factor for food production, manufacturing, and distribution companies, to enable the conformance of specifications, and to meet the key customer defined quality attributes is discussed in [51]. Several relevant quality management systems exist, such as HACCP (Hazard Analysis Critical Control Point), ISO (International Organisation for Standards), IFS (International Food Systems), BRC (British Retail Consortium), ACS (Approved Contractor Scheme), and QS (Quality System). The purpose of these systems is to ensure each process uses consistent controls, processes, and information input.

[52] highlighted five components to support quality management. These include quality control, quality improvement, quality assurance, quality design, and quality policy and strategy. Quality standards may be different in local markets compared to commercial markets [53], for example, in SFSCs, consumers are less likely to be turned away by "ugly" or non-uniform produce. The requirements and costs involved in supporting quality management in SFSC present challenges for actors, especially small scale farmers [11,32]. An alternative to traditional quality systems is the participatory guarantee system [54] that certify producers through active stakeholder participation, and are built on knowledge exchange and trust. Trust is important in both local and global food systems. [55] discuss trust through a series of food purchasing practices from self-provisioning, through local markets, to supermarket chains. Two important considerations for quality arise from [55] which reflects on 'personalised trust' (local markets and producers) and 'abstract guidance systems' (quality labels and certifications). [56] also show trust in respect to quality in local food systems, suggesting different levels that trust in quality is developed differently depending on the level of interaction between producers and consumers. To establish trust, SFSCs need to have distinct information about production steps, processing steps, and product specifications [13]. Loss of this trust may be critical to SFSC success.

The notion of locality is central to SFSCs and it has been reported that locality and quality are related in several ways. [13] discusses local and SFSCs through retailer channels in the UK, also presenting supply chain and quality assurance schemes. Price is also mentioned as an important consideration in consumer buying decisions. Challenges include defining terms, such as what is local vs locality [32]. Also, further understanding of policy and governance is needed to support these types of supply chains [57]. In alternative food supply chains, quality is discussed as a complex term that encompasses many characteristics. For example, consumers may perceive quality as a safety aspect, while producers use it to increase sales. Geographical indicators can also be an important quality indicator in SFSCs [58]. Geographical indication (GI) are place-based names that guarantee the origin of production. To assess SFSCs, [53] opined that quality results from both formal rules and informal guidelines. Informal rules or opinion conventions are based on the opinions of others. Ayala and Garner [59] research consumer behaviour at local farm markets. Perceived quality of the markets is based on health and local food production. In addition, trust plays a key role, as not all customers find the need for certification. Customers also find freshness, traceability, environmental, social aspects, and product-related features (taste, colour, and consistency), as important quality factors for SFSCs [60].

2.2. Blockchain Based Food Supply Chain

Digital transformation refers to the enablement of supply chains through novel technologies to create value [61].

Emerging from industry 4.0 are blockchain technologies [62], which have been researched in regards to the digital transformation of supply chains [63,64]. In principle, blockchain ledgers hold information like other ledger systems, for example, price, quantity, and quality. Blocks containing, timestamps, Merkle tree root and parent hash, nBits, and nonce are built together to represent a series of transactions, forming the blockchain [65]. Well-known blockchain characteristics include traceability, immutability, provenance, transparency, and the ability to create trust [28,66,67]. Blockchain provides positive impacts for food supply chains including improved and more fair prices, improved quality of products, and enhanced reporting of sustainability features [68]. Rapidly evolving user demand, unifying requirements, and system integration are discussed in the literature as some of the challenges for blockchain technology [27,68,69]. Potential benefits include integration of supply chains, improved quality, safety, and better control over sustainability. Other important factors are price, traceability, disintermediation, trust, and coordination.

Within blockchain, trust relates to the data stored and communicated between nodes. Product vulnerability in production and distribution processes may lead to variations of data and the real-time state of the product. To reduce these risks [35] and [70] introduce trust incentives and trust mechanisms in blockchain. Requirements identified for blockchain-based food supply chains include traceability, smart-contracts, disintermediation, accessibility, and privacy [67,71–74]. Associated digital technologies are also important. For example, [75] research the application of IoT in blockchain based traceability for food safety. [71] further investigated the topic of integrating RFID technologies. Other technologies linked to blockchain include big data, AI, and cloud based systems [76–78]. In addition to associated technologies is the consideration of smart contracts. Smart contracts through blockchain based systems have primarily focused on traceability issues in the supply chain. [79] present a smart contract to control the quality through different steps within a production process, improving monitoring through inbound material to delivery processes. Important to blockchain characteristics are 'boundary conditions, including business, supply chain, regulation, quality, traceability conditions, and architecture design [28,80,81]. Example blockchain based architectures related to this study are shown in Table 1.

Table 1 Example Architectures Related to This Study

Focus	Description and Architecture	Source
Food Traceability	A comprehensive literature study to propose a blockchain based traceability system in food supply chains. The blockchain architecture includes four layers, The business layer, descriptive the supply chain. The IoT showing the collection of specific data throughout each supply chain step. The blockchain layer is composed of data sets and smart contracts. The application layer, describing the quality, price, taxes, and logistics applications of the system.	[36]
Social Sustainability	A blockchain based social-sustainability architecture is presented. The architecture is divided into users, key applications, smart objects, communications channels, and the blockchain network. The multi-layer framework shows the importance of understanding applications, users, and associated technologies.	[37]
Food safety of grains	Research on potential blockchain platforms for the grain supply chain. Users identified as key requirements for the platform. The architects of the blockchain showed a data collection layer using IoT, and an application layer, a cloud service layer and a blockchain network layer.	[38]
Blockchain Based Quality Supply Chain	A blockchain based quality supply chain architecture is presented. The framework, presents a business layer, contract layer, data layer, and IoT Layer. Stakeholders are present in the business layer, the contract layer includes key applications, the blockchain/distributes ledger holds data, and the IoT layer is embedded with sensor systems.	[33]
End-to-end blockchain solution	Research that presents a complete blockchain based traceability food supply chain platform. Members included retailers, consumers processors, distributors, logistics companies, and producers, in addition, and an arbitrator is used to monitor the entire network. The proposed blockchain based solution includes features such as traceability, accountability, credibility, authenticity, automated payments, and a delivery mechanism. The architecture presented is a blockchain layer, traceability layer, storage layer, and data layer.	[82]
Blockchain based food traceability	A research presenting a blockchain based traceability architecture. The architecture having a consensus layer, data model layer, execution engine layer, and application layer. Advantages included improved precision due to the immutability and verification of data. A challenge being the slow speed of the system due to the system capacity.	[83]
Blockchain based agriculture traceability	A paper presenting an agriculture-based traceability system to track the movement from the point of production throughout the entire process. The proposed architecture includes a blockchain layer, a smart contract layer, an application layer, and an interface layer. The research further illustrates how the system can enhance and improve life cycle management within the entire supply chain.	[84]
Blockchain based trust	A three-layer architecture to support trust in blockchain based traceability platforms. The proposed architecture has a physical layer, data layer, blockchain layer, and application layer. Important in the system is that trust is rewarded and penalised, therefore intensifying supply chain members to ensure trustworthy data input.	[35]

In respect to blockchain based quality management of food supply chains, limited research is available, and the primary focus has been on traceability and food safety. Within the concept of blockchain based traceability, many current papers adopt the traceability framework in [34] as a starting point. The consideration of 'context awareness' is also identified and important in blockchain architecture [85]. The architectures in [35] and [86] are also relevant to this paper. The existing offerings of blockchain platforms in food supply chains and their architectures are mainly focused on conventional food chains, and not much tailored to the short chains in re-localised food systems. Specifics of SFSCs to account for in contrast to conventional food systems include a) personalised and direct relationships, b) quality management systems and their governance structures, c) stakeholder considerations and participatory guarantee systems. The key differences require attention, as existing blockchain architectures may not consider, for example, the importance of trust-reputation of the SFSC, and instead act as a tool to support conformance. The proposed architecture in this paper has offerings to collect, store, handle, and analyse supply chain information based on the requirements of these shorter supply chains.

3. Research Method

The main method adopted in this study is the traditional literature review covering: a) requirements for short food supply chain quality management, and b) blockchain based architectures relevant to this study. A traditional literature review is based on an objective and critical approach to literature assessment [87]. Key steps within the traditional literature review include selecting existing literature, understanding the material, analysing the material, synthesise, and evaluate developments [88]. These types of literature reviews should provide a comprehensive review of information within a knowledge area. A key limitation to the approach is the difficulty in reproducing results, showing a need for a more systematic approach. To overcome this issue, we adopt keywords and databases used to explore existing work. The steps applied to the literature review. Step 1: Identify research aim and set keywords, including short food supply chains (OR local food systems, alternative food systems, regional food systems), food quality (OR quality management), blockchain architecture (OR blockchain requirements). IEEE Explore, Scopus, Science Direct, and Emerald Insight were the databases used. Step 2 was the selection of articles was related to the scope of the research, showing short food supply chain quality, or blockchain requirements and architectures for food supply chain application. Step 3 included the analysis of documents, showing the stakeholder, quality, and blockchain requirements (see Figure 2), and showing the key components of relevant blockchain architectures (see Table 1). Based on these findings, a new blockchain architecture is proposed to meet the specific needs of short food supply chains.

4. Requirements

The physical supply chain is important to define when preparing an architecture as it illustrates the role of stakeholders, their requirement's, and the information collected from different parts of the supply chain. See Figure 1 for an overview of a SFSC.

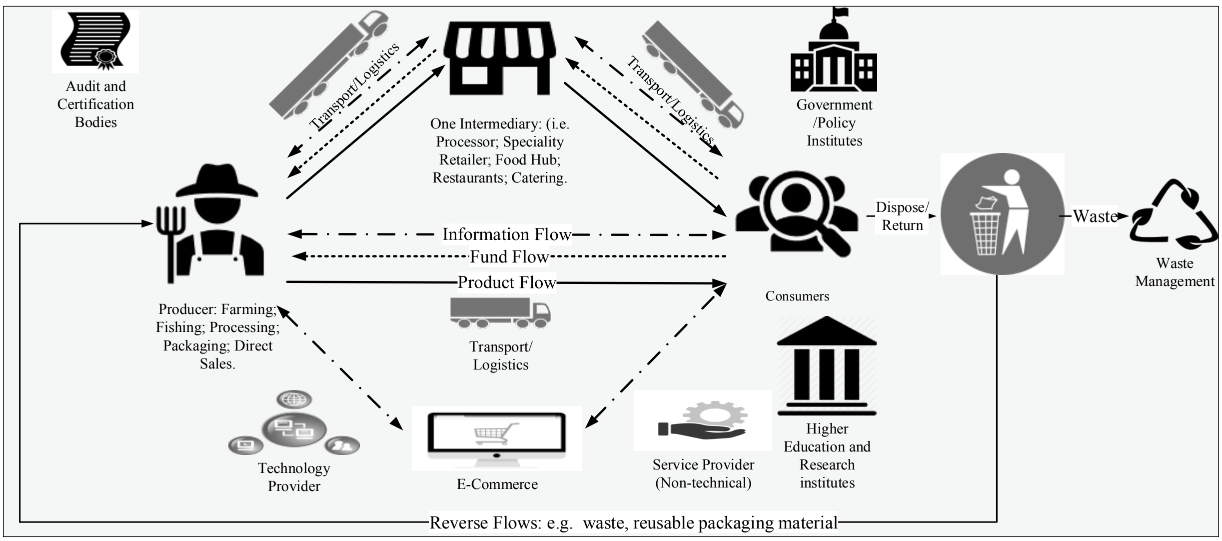

Figure 1 Short Food Supply Chain Overview

Requirements from the perspective of upstream stakeholders include equality, desire to grow (economics), value addition, brand development, new markets, organic production, close relationships, environmental sustainability, diversification, and disintermediation [89,90]. Downstream stakeholders require trust, intention, fair-trade, transparency, reduced asymmetric information, overcoming quality risks, value fairness, fair price, proof of origin, traceability, relationships, health, location, accessibility, typicality, gratifying, convenience, authenticity, supporting producers, and reduced food miles [42,91,92]. Requirements for SFSC quality are also shown in literature and include fair/just/ethical, ecological sustainability, health, safety, locality/origin, authenticity, product quality (taste, appearance), process quality, freshness, and artesian [17,18,95–103,24,53,57–60,93,94]. To support the identified quality requirements, 22 technological requirements are developed. Figure 2 shows the requirements.

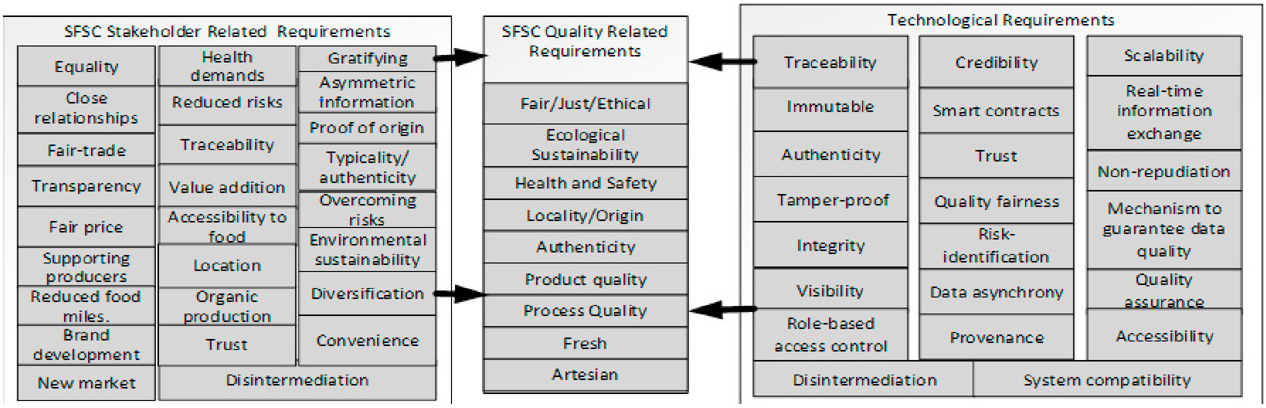

Figure 2 Summary of Requirements Emerging from Literature

The traceability system for food supply chains described in [34] is adapted and extended to model a blockchain based quality management system for SFSCs, see Figure 3. The adaptations include a) quality governance and standards, showing the formal and informal quality conventions, allowing for flexibility between different SFSCs, b) realisation of internal and external quality management, reflecting on internal processes within a company and supply chain processes. Trust/reputation are linked to each intermediary which is based on performance within the supply chain and the ability to meet agreements, which can be facilitated by smart contracts in business level stakeholders. The blockchain based quality management system show promise as a mechanism to guarantee quality standards and fairness [66]. Traceability and provenance are also important, supporting locality, process/product quality, and fair value distribution throughout the supply chain [13]. To enable quality and trust in the blockchain, IoT and communication technology is required.

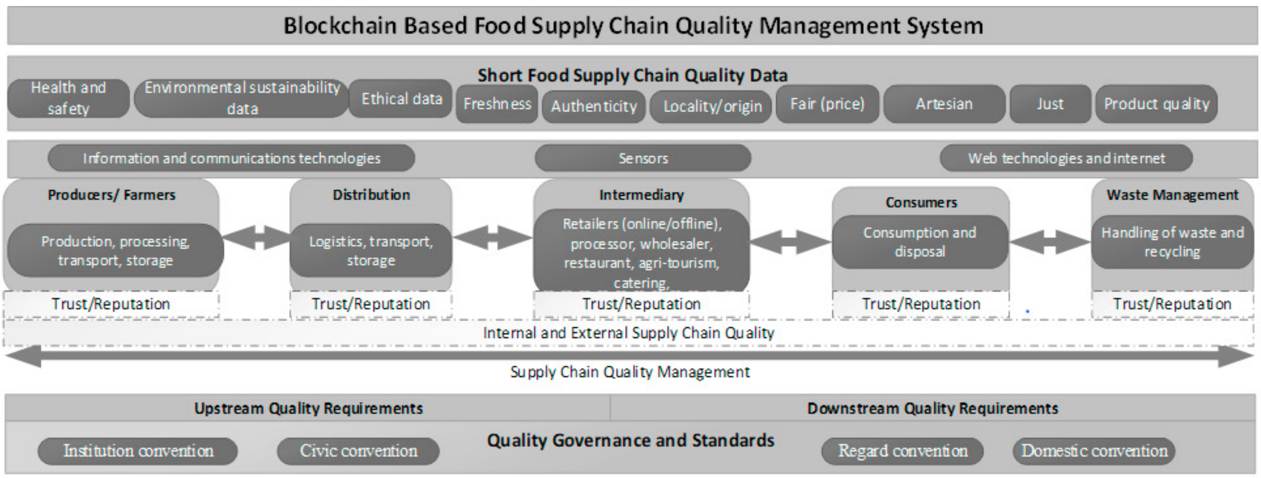

Figure 3 Outline View of Blockchain Based SFSC Quality Management System

5. Blockchain Based Architecture and Discussion.

A proposed multi-level architecture for blockchain based short food supply chain quality management is shown in Figure 4. The bottom layer is the business layer which defines the stakeholders of short food supply chains including producers, one potential intermediary, transport providers, and the end consumer. Other stakeholders are technical and non-technical service providers, auditing and certification bodies, higher education and research, government and

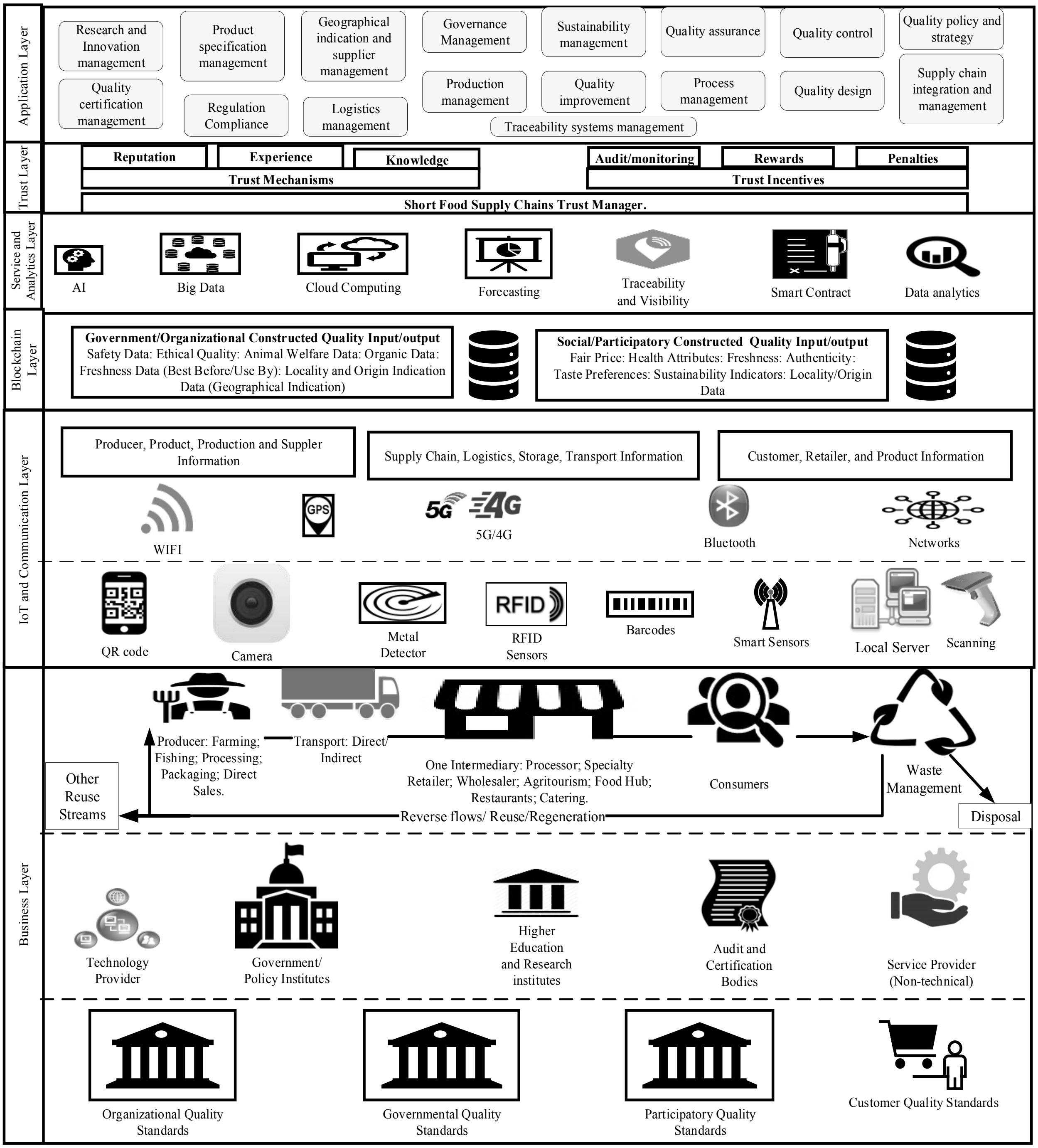

Figure 4 Blockchain Architecture for Short Food Supply Chain Quality Management and Trust

policy, and waste management. The business layer also includes standard-setting organisations in the supply chain. The second is the IoT and communication layer. This layer uses smart devices, sensors, and other IoT technologies to collect data along the supply chain. Information is then transferred through a communication channel. Important for this layer, is system compatibility, to connect to other technologies. The blockchain layer is third from the bottom. The blockchain layer offers immutable, tamperproof, asynchronous data. Important quality related data is stored at the blockchain layer. The fourth layer is the services and application layer. This layer uses associated technologies to improve data analysis, supply, and demand forecasting, monitor and rate stakeholder performance, and enable automation through smart contracts, also supporting mechanisms to ensure trust and quality. Next is the trust layer. This is an important layer for the management of trust in a short food supply chain quality management system. The trust layer including a trust mechanism to provide insight into the reputation, knowledge, and expertise of stakeholders, and provides incentives based on performance. At the top of the architecture is the application layer having the responsibility for supporting quality management in short food supply chains. The layer is accessible for SFSC stakeholders, however, role-based access control may be required here depending on the role of the stakeholders. Based on the architecture design some requirements are developed. The architecture should support system integration to collect, communicate, store, and analyse data between systems. furthermore, compatibility with existing company manufacturing and supply chain technologies is important. The system should not allow the alteration or deletion of data, through immutability, credibility, and a tamperproof system. To support authenticity, provenance, traceability, and visibility, it is important that the system sends real-time, live, information and updates about the origin and process steps of the product, supporting trust between supply chain stakeholders. For integrity, the system should support the management of physical goods through the integration of sensor embedded systems. For the concept of 'short food supply chains,' it is important that the system supports the reduction of intermediates where possible in the supply chain. Also, to create more efficient processes the system users can have different permissions concerning the role of stakeholders. A central consideration for the system is the monitoring, guidance, and guarantee of quality product flow in the supply chain. The automation of processes through for example smart contracts can support the reduction of bottlenecks through checking, approving and disproving transactions automatically. To ensure fairness the system should be unbiased, reduce potentials of human error, be transparent, and ensure that data on the system always remains available. To reduce the risk of disputes and further support trust, the system can ensure non-reputation. This can be enabled through for example digital signatures. In addition, a main advantage of the blockchain is the ability to securely store all previous transactions, to ensure immutable, tamper-proof data.

Several key differences are shown between the proposed architecture and existing architecture, cited in Table 1. First, none of the identified architectures cited in Table 1 directly focus on quality management in the short food supply chain. Instead, some include quality through traceability and sustainability in conventional systems. However, like existing architectures, are the layers of the physical supply chain and the communication layer, which are often responsible for data collection. The blockchain layer presented, is represented throughout existing architectures. However key differences within the layer are present.

6. Conclusion

The research presented in this paper aimed to develop a blockchain based architecture that can support short food supply chain quality management. First, a literature review to identify stakeholders, food quality, and blockchain requirements for short food supply chain quality management was conducted. Second, relevant existing architectures were reviewed to understand existing constructs and compare key differences for contribution. Although the existing architectures provided benefits for food supply chains, and quality management, none were built to support the unique requirements for short food supply chain quality management. The architecture proposed in this paper considers the key requirements for short food supply chain quality management enabled by blockchain technology. The architecture consists of supply chain stakeholders, IoT and communication networks, a blockchain layer, data analysis and service capabilities, trust incentives and mechanisms, and applications related to quality management. Based on the literature, it is concluded that blockchain offers considerable potential benefits to short food supply chain quality management through enabling trust, traceability, provenance, authenticity, and visibility. In addition, technical adoption considerations such as immutability, non-repudiation, system integration, smart contracts, and real-time information are required to create trust within the system. Identified in the literature are considerations that may act as a barrier to blockchain adoption. These reflecting on the costs of the system, usability, and organisational barriers. Critical to the blockchain architecture, is the consideration of trust and reputation, motivating, monitoring, and providing an incentive to improve supply chain quality management within the short supply chains. The complexity of trust leads to a need for further research, as the construct and development of trust are complex and vary between food systems. Second, the blockchain layer provides a unique ability to store specific quality related data for the short food supply chain, therefore supporting non-repudiation. Upper layers may improve the standardisation of practices through applications to support stakeholders. Future work can focus on the implementation and validation of the proposed architecture. A limitation of the research is the theoretical approach which can be supported by empirical investigation.

References

[1] Fonte M. Introduction: Food relocalisation and knowledge dynamics for sustainability in rural areas. Namin Food After Places Food Relocalisation Knowl Dyn Rural Dev 2010:1–35.

[2] Gereffi G, Humphrey J, Sturgeon T. The governance of global value chains. Rev Int Polit Econ 2005;12:78–104.

[3] Renting H, Marsden TK, Banks J. Understanding alternative food networks: exploring the role of short food supply chains in rural development. Environ Plan A 2003;35:393–411.

[4] Papangelou A, Achten WMJ, Mathijs E, Ambrose G, Das K, Fan Y, et al. An insight into agri-food supply chains: A review. Sustain 2020;9:1–18.

[5] Trivette SA. How local is local? Determining the boundaries of local food in practice. Agric Human Values 2015;32:475–90.

[6] Dani S. Food supply chain management and logistics: From farm to fork. Kogan Page Publishers; 2015.

[7] Paciarotti C, Torregiani F. The logistics of the short food supply chain: A literature review. Sustain Prod Consum 2021;26:428–42.

[8] Thomé KM, Cappellesso G, Ramos ELA, Duarte SC de L. Food Supply Chains and Short Food Supply Chains: Coexistence conceptual framework. J Clean Prod 2021;278:123207. h

[9] Jarzębowski S, Bourlakis M, Bezat-Jarzębowska A. Short Food Supply Chains (SFSC) as Local and Sustainable Systems. Sustain 2020;12. [10] Kneafsey M, Venn L, Schmutz U, Balázs B, Trenchard L, Eyden-Wood T, et al. Short Food Supply Chains and Local Food Systems in the EU. A State of Play of their Socio-Economic Characteristics. 2013.

[11] Kurnia S, Hill S, Rahim MM, Larsen K, Braun P, Samson D. Open Food Network: The role of ICT to support regional food supply chains in Australia. ArXiv Prepr ArXiv160601456 2016.

[12] Chiffoleau Y, Dourian T. Sustainable Food Supply Chains: Is Shortening the Answer? A Literature Review for a Research and Innovation Agenda. Sustainability 2020;12:9831.

[13] Sellitto MA, Vial LAM, Viegas CV. Critical success factors in Short Food Supply Chains: Case studies with milk and dairy producers from Italy and Brazil. J Clean Prod 2018;170:1361–8.

[14] Robinson CJ, Malhotra MK. Defining the concept of supply chain quality management and its relevance to academic and industrial practice. Int J Prod Econ 2005;96:315–37.

[15] Song H, Turson R, Ganguly A, Yu K. Evaluating the effects of supply chain quality management on food firms' performance: The mediating role of food certification and reputation. Int J Oper Prod Manag 2017;37:1541–62. [16] Peri C. The universe of food quality. Food Qual Prefer 2006;17:3–8.

[17] Lamine C, Garçon L, Brunori G. Territorial agrifood systems: A Franco-Italian contribution to the debates over alternative food networks in rural areas. J Rural Stud 2019;68:159–70.

[18] Vistocco D, Papetti P, Spognardi S, Cappelli L. Impact of organic and "protected designation of origin" labels in the perception of olive oil sensory quality. Br Food J 2021;ahead-of-p.

[19] Cuéllar-Padilla M, Ganuza-Fernandez E. We Don't Want to Be Officially Certified! Reasons and Implications of the Participatory Guarantee Systems. Sustain 2018;10.

[20] Chan SW, Tiwari S, Ramlan R, Ahmad F. The Relationship between Leadership Styles and Quality Management Practices in Malaysian Manufacturing Firms. 2018.

[21] Luthra S, Garg D, Yadav S. Development of IoT based data-driven agriculture supply chain performance measurement framework. J Enterp Inf Manag 2020;34:292–327. [22] Ji C, Chen Q, Zhuo N. Enhancing consumer trust in short food supply chains. J Agribus Dev Emerg Econ 2019;10:103–16.

[23] Burgess PR, Sunmola FT. Prioritising Requirements of Informational Short Food Supply Chain Platforms Using a Fuzzy Approach. Procedia Comput Sci 2021;180:852–61.

[24] Oncini F, Bozzini E, Forno F, Magnani N. Towards food platforms? An analysis of online food provisioning services in Italy. Geoforum 2020;114:172–80.

[25] Saetta S, Caldarelli V. How to increase the sustainability of the agri-food supply chain through innovations in 4.0 perspective: a first case study analysis. Procedia Manuf 2020;42:333–6.

[26] Prugger R, Reynolds C, Dowgielwicz T, Calabrese J, Contini L, Holt GC, et al. Research agenda for SMEs in electronic platforms for the European food industry. Foresight 2007;9:42–53. [27] Lezoche M, Hernandez JE, Alemany Díaz M del ME, Panetto H, Kacprzyk J. Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. Comput Ind 2020;117:103187.

[28] Köhler S, Pizzol M. Technology assessment of blockchain-based technologies in the food supply chain. J Clean Prod 2020;269:122193.

[29] Panetto H, Lezoche M, Hernandez Hormazabal JE, del Mar Eva Alemany Diaz M, Kacprzyk J. Special issue on Agri-Food 4.0 and digitalization in agriculture supply chains - New directions, challenges and applications. Comput Ind 2020;116:103188.

[30] Lioutas ED, Charatsari C. Smart farming and short food supply chains: Are they compatible? Land Use Policy 2020;94:104541.

[31] Wang T, Xu X, Wang C, Li Z, Li D. From smart farming towards unmanned farms: A new mode of agricultural production. Agric 2021;11:1–26.

[32] Zwart TA, Wertheim-Heck SCO. Retailing local food through supermarkets: Cases from Belgium and the Netherlands. J Clean Prod 2021;300:126948.

[33] Chen S, Shi R, Ren Z, Yan J, Shi Y, Zhang J. A Blockchain-Based Supply Chain Quality Management Framework. 2017 IEEE 14th Int. Conf. E-bus. Eng., 2017, p. 172–6.

[34] Aung MM, Chang YS. Traceability in a food supply chain: Safety and quality perspectives. Food Control 2014;39:172–84.

[35] Malik S, Dedeoglu V, Kanhere SS, Jurdak R. Trustchain: Trust management in blockchain and iot supported supply chains. 2019 IEEE Int. Conf. Blockchain, IEEE; 2019, p. 184–93.

[36] Feng H, Wang X, Duan Y, Zhang J, Zhang X. Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges. J Clean Prod 2020;260:121031.

[37] Venkatesh VG, Kang K, Wang B, Zhong RY, Zhang A. System architecture for blockchain based transparency of supply chain social sustainability. Robot Comput Integr Manuf 2020;63:101896.

[38] Zhang X, Sun P, Xu J, Wang X, Yu J, Zhao Z, et al. Blockchain-Based Safety Management System for the Grain Supply Chain. IEEE Access 2020;8:36398–410.

[39] Beinke JH, Fitte C, Teuteberg F. Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study. J Med Internet Res 2019;21:e13585.

[40] Carter E. Desperately seeking happy chickens: producer dynamics and consumer politics in quality agricultural supply chains. Int J Soc Econ 2020;ahead-of-p.

[41] Marotta G, Nazzaro C, Simeone M. Human capital and social capital in the multifunctional agriculture: An analysis of the short supply chain experiences in the inland of Campania . Econ Agro-Alimentare 2013;15:149–73.

[42] Giampietri E, Verneau F, Del Giudice T, Carfora V, Finco A. A Theory of Planned behaviour perspective for investigating the role of trust in consumer purchasing decision related to short food supply chains. Food Qual Prefer 2018;64:160–6.

[43] Wertheim-Heck S, Levelt M, Ten Brug L, Van Bossum J. Advancing the evidence base for sustainable city-region food systems 2018.

[44] Gaast K, Leeuwen E, Wertheim-Heck S. City-Region Food Systems and Second Tier Cities: From Garden Cities to Garden Regions. Sustainability 2020.

[45] Jarzębowski S, Bezat N. Supply chain management according to the concept of short supply chain. Proc Food Syst Dyn 2018:313–20.

[46] Betty Chang, Camila Massri, Malou Reipurth, Sophie Hieke A, Hegyi, Katalin Kujáni, Ágnes Major, Ágnes Szegedyné Fricz K, Varsányi, Verena Hüttl-Maack, Dennis Gawlik EP, Begoña Alfaro, Elena Santa Cruz, Camille Aouinaït, Zsuzsan Proos J, Kuitems FJ. Deliverable 4.2. Report on the stakeholder interviews. Hohenheim: 2019.
[47] Elghannam A, Escribano M, Mesias F. Can social networks contribute to the development of short supply chains in the Spanish agri-food sector? New Medit 2017;16:36–42.
[48] Song H, Turson R, Ganguly A, Yu K. Evaluating the effects of supply chain quality management on food firms' performance. Int J Oper Prod Manag 2017;37:1541–62.
[49] Siddh MM, Jain R, Sharma MK, Soni G. Structural model of perishable food supply chain quality (PFSCQ) to improve sustainable organizational performance. Benchmarking An Int J 2018;25:2272–317.
[50] Alsawafi A, Lemke F, Yang Y. The impacts of internal quality management relations on the triple bottom line: A dynamic capability perspective. Int J Prod Econ 2021;232:107927.
[51] Siddh MM, Jain R, Yadav V, Sharma MK, Soni G. Agri-fresh food supply chain quality (AFSCQ): a literature review. Ind Manag Data Syst 2017;117:2015–44.
[52] Dora M, Kumar M, Van Goubergen D, Molnar A, Gellynck X. Food quality management system: Reviewing assessment strategies and a feasibility study for European food small and medium-sized enterprises. Food Control 2013;31:607–16. https://doi.org/https://doi.org/10.1016/j.foodcont.2012.12.006.
[53] Matzembacher DE, Meira FB. Sustainability as business strategy in community supported agriculture. Br Food J 2019;121:616–32.
[54] Loconto A, Hatanaka M. Participatory guarantee systems: Alternative ways of defining, measuring, and assessing 'sustainability.' Sociol Ruralis 2018;58:412–32.
[55] Wertheim-Heck SCO, Spaargaren G. Shifting configurations of shopping practices and food safety dynamics in Hanoi, Vietnam: a historical analysis. Agric Human Values 2016;33:655–71.
[56] Prigent-Simonin A-H, Hérault-Fournier C. The role of trust in the perception of the quality of local food products: with particular reference to direct relationships between producer and consumer. Anthropol Food 2005.
[57] Ilbery B, Maye D. Retailing local food in the Scottish–English borders: A supply chain perspective. Geoforum 2006;37:352–67.
[58] Bowen S, Zapata AV. Geographical indications, terroir, and socioeconomic and ecological sustainability: The case of tequila. J Rural Stud 2009;25:108–19. [59] Ayala C, Garner B. Regional tourism at the farmers' market: consumers' preferences for local food products. Int J Cult Tour Hosp Res 2019;13:37–54.
[60] Degreef G, Kallas Z, Casellas K, Gil JM, Berges M, Alba MF. The development of short food supply chain for locally produced honey. Br Food J 2019;ahead-of-p. [61] Wiedenmann M, Größler A. The impact of digital technologies on operational causes of the bullwhip effect – a literature review. Procedia CIRP 2019;81:552–7.
[62] Hopkins JL. An investigation into emerging industry 4.0 technologies as drivers of supply chain innovation in Australia. Comput Ind 2021;125:103323. [63] Sunmola FT, Burgess PR, Tan A. Building Blocks for Blockchain Adoption in Digital Transformation of Sustainable Supply Chains. FAIM 2021 Under Rev., 2021.
[64] Sunmola FT, Burgess PR, Tan A. A Meta-Review of Blockchain Adoption Literature in Supply Chain. 4th Work. Blockchain Smart Contract Technol. (BSCT 2021), In press; 2021.
[65] Zheng Z, Xie S, Dai H, Chen X, Wang H. An overview of blockchain technology: Architecture, consensus, and future trends. 2017 IEEE Int. Congr. big data (BigData Congr., IEEE; 2017, p. 557–64.
[66] Yadav S, Singh SP. Blockchain critical success factors for sustainable supply chain. Resour Conserv Recycl 2020;152:104505.
[67] Garaus M, Treiblmaier H. The influence of blockchain-based food traceability on retailer choice: The mediating role of trust. Food Control 2021:108082.
[68] Kamilaris A, Fonts A, Prenafeta-Boldύ FX. The rise of blockchain technology in agriculture and food supply chains. Trends Food Sci Technol 2019;91:640–52.
[69] Galvez JF, Mejuto JC, Simal-Gandara J. Future challenges on the use of blockchain for food traceability analysis. TrAC Trends Anal Chem 2018;107:222–32.
[70] Truong N, Lee GM, Sun K, Guitton F, Guo Y. A blockchain-based trust system for decentralised applications: When trustless needs trust. Futur Gener Comput Syst 2021;124:68–79. [71] Tian F. A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. 2017 Int. Conf. Serv. Syst. Serv. Manag., 2017, p. 1–6.
[72] Lin W, Huang X, Fang H, Wang V, Hua Y, Wang J, et al. Blockchain Technology in Current Agricultural Systems: From Techniques to Applications. IEEE Access 2020;8:143920–37.
[73] Xu J, Guo S, Xie D, Yan Y. Blockchain: A new safeguard for agri-foods. Artif Intell Agric 2020;4:153–61.
[74] Lin Q, Wang H, Pei X, Wang J. Food Safety Traceability System Based on Blockchain and EPCIS. IEEE Access 2019;7:20698–707.
[75] Torky M, Hassanein AE. Integrating blockchain and the internet of things in precision agriculture: Analysis, opportunities, and challenges. Comput Electron Agric 2020;178:105476.
[76] Caro MP, Ali MS, Vecchio M, Giaffreda R. Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. 2018 IoT Vert. Top. Summit Agric. - Tuscany (IOT Tuscany), 2018, p. 1–4.
[77] Yang L, Liu X-Y, Kim JS. Cloud-based Livestock Monitoring System Using RFID and Blockchain Technology. 2020 7th IEEE Int. Conf. Cyber Secur. Cloud Comput. (CSCloud)/2020 6th IEEE Int. Conf. Edge Comput. Scalable Cloud, 2020, p. 240–5.
[78] Baralla G, Pinna A, Corrias G. Ensure Traceability in European Food Supply Chain by Using a Blockchain System. Proc. 2nd Int. Work. Emerg. Trends Softw. Eng. Blockchain, IEEE Press; 2019, p. 40–47.
[79] Yu B, Zhan P, Lei M, Zhou F, Wang P. Food quality monitoring system based on smart contracts and evaluation models. IEEE Access 2020;8:12479–90.
[80] Behnke K, Janssen MFWHA. Boundary conditions for traceability in food supply chains using blockchain technology. Int J Inf Manage 2020;52:101969.
[81] Bumblauskas D, Mann A, Dugan B, Rittmer J. A blockchain use case in food distribution: Do you know where your food has been? Int J Inf Manage 2020;52:102008.
[82] Shahid A, Almogren A, Javaid N, Al-Zahrani FA, Zuair M, Alam M. Blockchain-Based Agri-Food Supply Chain: A Complete Solution. IEEE Access 2020;8:69230–43.
[83] Hayati H, Nugraha IGBB. Blockchain Based Traceability System in Food Supply Chain. 2018 Int. Semin. Res. Inf. Technol. Intell. Syst., 2018, p. 120–5.
[84] Hong W, Cai Y, Yu Z, Yu X. An agri-product traceability system based on iot and blockchain technology. 2018 1st IEEE Int. Conf. Hot Information-Centric Netw., IEEE; 2018, p. 254–5.
[85] Sunmola FT. Context-Aware Blockchain-Based Sustainable Supply Chain Visibility Management. Bus. Process Manag., 2019.
[86] H. A, S. C, A. R, L.P. R, editors. 6th World Conference on Information Systems and Technologies, WorldCIST 2018 2018;747.
[87] Martínez-Jurado PJ, Moyano-Fuentes J. Lean management, supply chain management and sustainability: a literature review. J Clean Prod 2014;85:134–50.
[88] Onwuegbuzie AJ, Frels R. Seven steps to a comprehensive literature review: A multimodal and cultural approach 2016.
[89] Zirham M, Palomba R. Female Agriculture in the Short Food Supply Chain: A New Path towards the Sustainability Empowerment. Agric Agric Sci Procedia 2016;8:372–7.
[90] Michel-Villarreal R, Vilalta-Perdomo EL, Hingley M. Exploring producers' motivations and challenges within a farmers' market. Br Food J 2020;122:2089–103.
[91] Chiffoleau Y, Millet-Amrani S, Rossi A, Rivera-Ferre MG, Merino PL. The participatory construction of new economic models in short food supply chains. J Rural Stud 2019;68:182–90.
[92] Del Giudice T, Finco A, Giampietri E. Exploring consumers' behaviour towards short food supply chains. Br Food J 2016;118:618–31.
[93] Sage C. Social embeddedness and relations of regard:: alternative 'good food' networks in south-west Ireland. J Rural Stud 2003;19:47–60.
[94] Galli F, Prosperi P, Favilli E, D'Amico S, Bartolini F, Brunori G. How can policy processes remove barriers to sustainable food systems in Europe? Contributing to a policy framework for agri-food transitions. Food Policy 2020;96:101871.
[95] Milestad R, Bartel-Kratochvil R, Leitner H, Axmann P. Being close: The quality of social relationships in a local organic cereal and bread network in Lower Austria. J Rural Stud 2010;26:228–40.
[96] Freidberg S, Goldstein L. Alternative food in the global south: Reflections on a direct marketing initiative in Kenya. J Rural Stud 2011;27:24–34.
[97] Milestad R, Kummer S, Hirner P. Does scale matter? Investigating the growth of a local organic box scheme in Austria. J Rural Stud 2017;54:304–13. h
[98] Goszczyński W, Wróblewski M. Beyond rural idyll? Social imaginaries, motivations and relations in Polish alternative food networks. J Rural Stud 2020;76:254–63.
[99] Benson T, Lavelle F, Spence M, Elliott CT, Dean M. The development and validation of a toolkit to measure consumer trust in food. Food Control 2020;110.
[100] Thomé KM, Pinho GM, Hoppe A. Consumption values and physical activities: consumers' healthy eating choices. Br Food J 2019;121:590–602.
[101] Mancini MC, Arfini F. Short supply chains and protected designations of origin: The case of parmigiano reggiano (Italy) . Ager 2018;2018:43–64.
[102] Goodman D, Goodman MK. Food Networks, Alternative. In: Kitchin R, Thrift NBT-IE of HG, editors., Oxford: Elsevier; 2009, p. 208–20.
[103] Matzembacher DE, Carmo Stangherlin ID, Slongo LA, Cataldi R. An integration of traceability elements and their impact in consumer's trust. Food Control 2018;92:420–9.