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BLOCKCHAIN TECHNOLOGY IN AGRO-INDUSTRIAL SUPPLY CHAIN: REVIEW

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Abstract *This paper provides a review of the application of blockchain technology in industrial supply chains in general. It aims to investigate how current blockchain technology is and its applications and to look for research loopholes that have not been done before. The theory of several research papers that have been published in journals to date, along with several reports from the grayish literature as a means of streamlining judgments about growing blockchain-based supply chains is included in this review. The research step is to identify papers based on the year of publication so that a theory-based understanding of blockchain technology in the Agro-Industrial Supply Chain ecosystem, between 2007 and 2019. Blockchain technology in the agro-industry supply chain described in the framework in 2018 is 6.57%, while the implication for the case study is 9.11% and identified in the hypothesis with a questionnaire regarding blockchain recognition and exploration so that 4.5% of the blockchain model simulation. Based on the graph, there are 52% of blockchain research articles on the agro-industrial supply chain will be followed up by researchers, thereby increasing the value chain in the agro-industry more. Research that discusses the value (value) in the supply chain that occurs from upstream to downstream in the agro-industrial supply chain ecosystem is very little, only around 2%. Excellence blockchain can identify the stakeholders that exist in the supply chain in each ecosystem from upstream to downstream processes so that it can transform a rigid and uncertain supply chain system into an efficient performance supply chain with transparency and trust between stakeholders so that integration, collaboration, and accuracy accurate data information*

Keywords*:* Agro-industry, Blockchain, Supply Chain

1. Introduction

Agriculture is an important and complex large industry. This can be seen from the long and inefficient agricultural supply chain [1], the large scale of the chain, the non-transparent network, and the lack of communication between upstream and downstream actors [2]. Agricultural products that will be consumed by the community, have a multi-actor and distributed basis, such as farmers, processors, distributors, and markets or end consumers [3]. The lack of transparency makes it difficult to trace the problems that occur such as the area of origin of the product, the production ecosystem, and price justice from farmers to consumers [4]. So far, pressure from the government, food crisesand food pollution have greatly disturbed the final consumer. So that during the pandemic and era 4.0, agricultural products can display qualityand quantity that is following the wishes of all stakeholders.

Precision farming is one of the important components of the smart agriculture market. The smart agriculture market alone is projected to grow from $5.18 billion in 2016 to $1.23 billion in 2022, with a compound annual growth rate of 13.27% between 2017 and 2022 [5].

The supply chain system used today is a centralized supply chain system. Which has weaknesses in issues of trust and transparency of information and does not go according to the original plan where fraud and inaccuracies oftenoccur. This is possible because most supply chain agents may not share information fairly due to privacy policies, data quality of information, and inaccuracies. The supply chain is a relationship of more than two integrated agents that aims to create and provide added value to end consumers in the distribution network. Throughout the agro-industry supply chain, stakeholders play an important role in data flow information, both quality data ranging from commodities to products that are ready to be consumed at the consumer's table. As for the flow of quantitative data, it is the accuracy of the number of products produced by each actor so

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that consumers do not feel lacking and lose products when the season is not or not yet harvested Currently, each actor along the supply chain is still busy optimizing personal conditions regardless of the state of performance along the supply chain from upstream to downstream [6]. Currently, the database system used throughout the supply chain is a centralized database, with a database that is still simple and not integrated between stakeholders. One of the disadvantagesis that the database is easy to hack until the data is lost. The technology that has just been introduced now is blockchain-based which is decentralized [7], characterized by independent asymmetry [8]. Blockchain technology providesan opportunity as a transformation in improvingagricultural supply chain operations that willmake it easier for small farms to compete with large companies [9]. Improving the performance of the agro-industry supply chain can be done by product traceability, regional origin, and quantity accuracy [10]. Traceability is the ability to present information related to the history and movement of an item/object through each stage of the production and distribution process [11]. This system requires supply chain actors to knowwho supplies and to whom the products are sent so that each actor has access to transaction data information from upstream to downstream [12]. The characteristics of blockchain that make it an attractive alternative for traceability in agroindustrial supply chains are distribution ledgers with the involvement of all actors, decentralized and synchronized databases [13]. Although Blockchain is currently in greatdemand and is starting to be implemented in Indonesia, there is still a dearth of literature discussing blockchain technology in agro- industrial supply chains. Because in addition to relatively new applications, blockchain developers are still rare in designing transaction platforms for the distribution of data information using intelligent tools in cloud, web, and Android applications [14]. Therefore, this paper provides a critical review of what blockchain is based on articles, objectives, benefits and challenges, steps, and blockchain implementations that have been carried out by previous researchers on agro-industrial supply chains in increasing value efficiency.

2. Methods

The flow chart of the research process in making a review is described below. The researcher first collects literature related to agro-industry, supply chains, then blockchain technology. The following is a description of the flow of the research process carried out by researchers

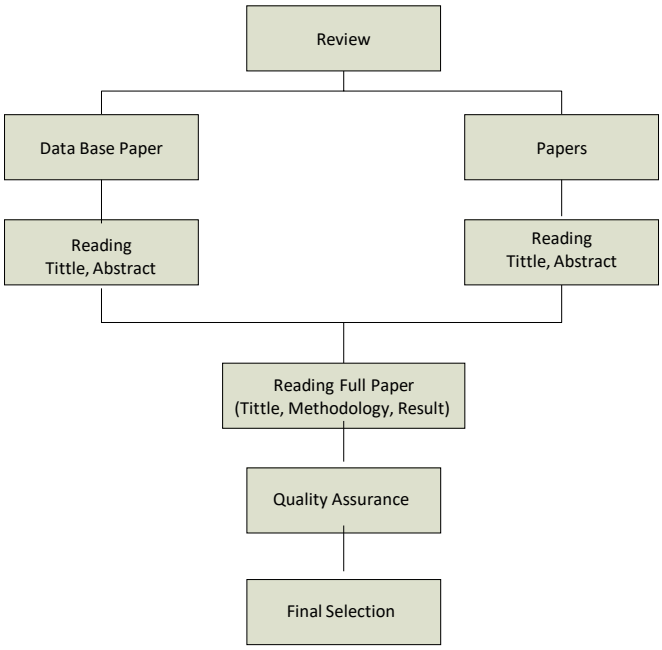

Fig 1. Review Completion Flow

3. Results

3.1 Classification of Blockchain Technology in Agro-Industrial Supply Chains.

Identification of papers by year, there are about 80 abstracts that discuss blockchain issues in the agro-industrial supply chain ecosystem, from 2007 to 2020. The number of papers that are discussed more in this study is papers published in 2018. With a filtering process based on relevance, namely Research discussing blockchain, managerial implications in an agro-industrial system based on function, the purpose of benefits to challenges in its application, after that how to implement blockchain in agro-industry both in inventory, distribution, production processes to utilization by end consumers.

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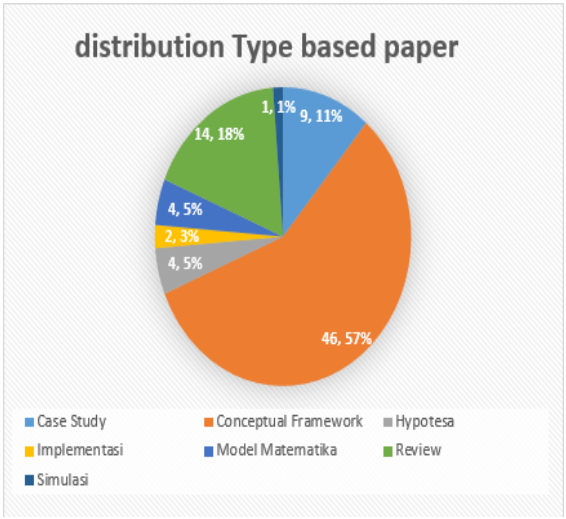

Fig 2. Types of Articles/Papers

Based on the papers read and reviewed, it can be stated that blockchain technology in the supply chain will continue to develop in the future. Evidenced by the number of papers obtained through searching google scholar, science direct, the research gate in 2018 was 6.57%, while the implication of case studies was 9.11% and identified in the hypothesis by distributing questionnaires regarding the introduction and exploration of blockchain up to 4.5% blockchain model simulation is possible and the rest is under review, implementation and mathematical model.

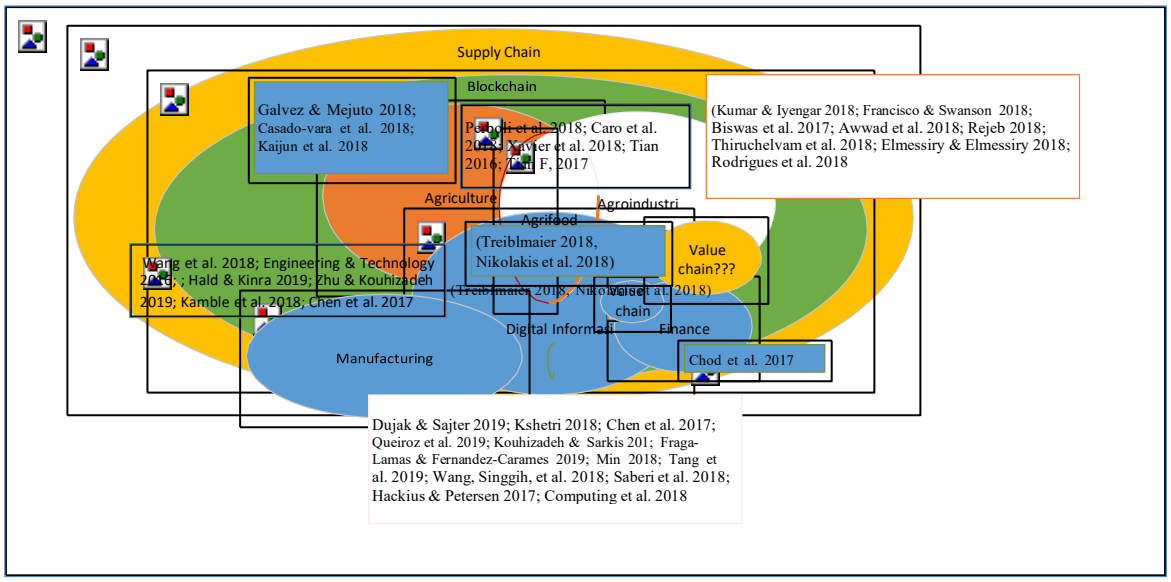

Fig 3. Clustering Blockchain Research in Supply Chain

The grouping of papers begins with a review of the supply chain in general, after that the paper that discusses blockchain. Blockchain application papers are grouped by areas as discussed in [15], [16], [17]. The grouping of blockchain-based papers in agriculture and food supply chains is also discussed in papers [18], [19], [20], [21], arguing that blockchain technology provides a platform of openness, traceability, transparency so that it can integrate all actors based on needs analysis using IoT tools, web base by ensuring security, resilience, and sustainability. The platform used to carry out trusted data flow transactions between actors without third parties, recordings made for inter-chain security coupled with the accuracy of digital signatures for public verification.

Furthermore, blockchain grouping in agro-industrial supply chains discusses more traceability [22], and transparency [23], [24]. The use of a decentralized system is an important element of blockchain in increasing supply chain efficiency [25], as well as streamlining agro-industry supply chains so that consumers do not have to worry about quality [26], such as halal meat consumed, product safety to product involvement and distribution [27]. The agro-industry sector is a very potential field in the application of blockchain technology [28], [29] because as a service provider to produce food [30], the consumers want to know the quality, the sources of raw materials, the historical journey of the product from upstream to downstream., transaction contracts will be halal, product

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quality hygiene is like during this pandemic [31].

Blockchain integration is divided into several theories in its application in supply chain management, namely: PAT (principal-agent theory), TCA (transaction cost analysis), RBV (resource-based view), NT (network theory) to generate value in logistics business processes. Information flow, product. and finance is an inseparable part if we talk about the supply chain [32], [33]. Blockchain, therefore, has the potential to increase transparency and traceability in agroindustrial supply chains through immutable data transaction flows, distributed storage, and controllable user access [34], [35]. The influence of blockchain on a sustainable supply chain was evaluated by ranking using TOPSIS [36], [37]. At the strategic level the diversity and recency of smart contracts [50], as a platform that defines protocols in building consensus from input/output transactions, the existence of the trust, security, transparency, storage of value as success in supply networks [38]. Whereas in the early days of blockchain implementation, more in financial management was more about securing financing, transparent transaction flow, and also censorship of financial performance between companies [39], [40].

The blockchain technology framework in the supply chain is divided into 4 main layers, namely the lowest layer is IoT, Sensor Layer (GPS), barcodes. The second layer is the distribution of data entered in a secure distributed ledger, the third layer is a contract or agreement between stakeholders. Effectively, it can be converted into computer code and then stored and replicated on a computer system and monitored by a computer network running the blockchain in the form of business processes [41], [42]. Smart contracts facilitate stakeholder requirements for submitting, verifying, and signing. The business layer of each company in the supply chain can control and manage the chain both in terms of product quality and quantity.

3.2 Integration of papers

Based on a cone-shaped system integration structure to blockchain-based solutions in the agro-industrial supply chain. The grouping of journals is divided into several discussion topics such as those discussing agriculture, agrifood, agroindustry, digital information, manufacturing, and value chains. The articles are grouped according to a common theme, namely papers discussing blockchain implementation in supply chains. The collected papers are dominated by a variety of blockchain applications in the supply chain in the field of digital information.

Blockchain was first conceptualized by a person (or group of people) known as Satoshi Nakamoto (2008). For almost a decade Nakamoto described how blockchain technology, a peer-to-peer connected structure, can be used to solve problems in keeping order transactions and to avoid spending problems [43]. By leveraging blockchain, bitcoin has become the first digital currency that can overcome double-spending without the need for a trusted authority and is an inspiration for other applications. One of the papers that discusses the integration between blockchain applications in the supply chain discusses added value from a financial perspective such as blockchain implementation in e-commerce, while research on gaps or gaps in the application of blockchain in supply chains explores value in agricultural supply chain systems [44], [45].

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Table 1. Comparison Based on Potential Blockchain Data

No	Authors	The potential value of data transactions on the blockchain										Settlement Method
		improvement		Reduction		Prediction		Identification		Escalation		
		SC	Non-SC	Risk	Cost	Demand	Non Demand	Opportunity	Risk	Safety	Quality	
1	(Monjelat et al. 2018)	v		V					v	V	v	Hyperledger Sawtooth
2	(Awwad et al. 2018)	v		V					v	V		Internet of Thing (IoT)
3	(Galvez & Mejuto 20	v		V					v	V		Sensor (RFID)
4	(Kumar & Iyengar 2018)	v		V					v			Smart Contract by EVM and Ether (Solidity programming language)
5	(Y.-P. Lin et al. 2017)		v	V							v	Infrastructure BC (ICT)
6	Casado-vara et al. 2018)	v						V		V		A smart Contract multi-agent systems (5 Layers)
7	(Perboli et al. 2018)	v			v			V			v	Design use case, GUEST (GO, UNIFORM, EVALUATE, SOLVE, and TEST)
8	(Xavier et al. 2018)	v						V				Qualitative identification based on previous research projects
9	(Tse et al. 2018)	v						V			v	Making blocks to produce hash statistics (coin confirmation)
10	(Caro et al. 2018)	v						V				Ethereum and Hyperledger Sawtooth
11	(Tian 2016)	v						V		V		RFID & blockchain
12	(Kaijun et al. 2018)	v				V					v	Consensus Algorithm
13	Tian F, 2017	v							v	V		RFID & blockchain-based on HACCP
14	(Francisco & Swanson 2018)	v			v	V		V				Unified Theory of Acceptance and Use of Technology (UTAUT) and technology innovation
15	(Biswas et al. 2017)	v							v		V	Blockchain-based traceability system for counterfeit wines
16	(Rejeb 2018)	v		v					v		V	Blockchain-based halal traceability system (HACCP) is based on Islamic law
17	(Thiruchelvam et al. 2018)	v			v			V			V	Based on qualitative data by distributing questionnaires

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3.3 Research Gaps

The following figure describes the research gap that occurred, based on the collected and reviewed journals, there are 52% of papers discussing blockchain in the supply chain will have the opportunity to be followed up in the design of the agro-industry supply chain system. Then researchers take the values that occur along the supply chain to be further deepened.

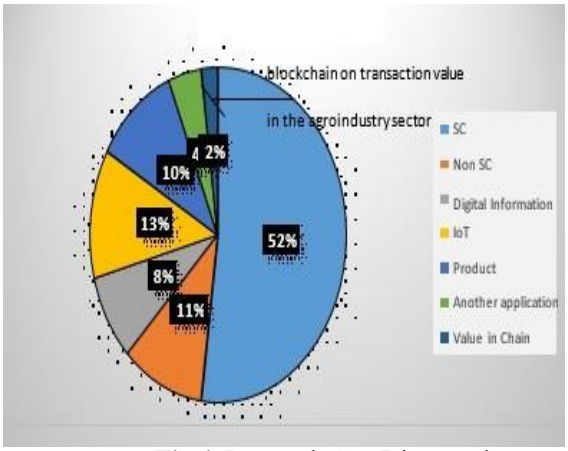

Fig 4. Research Gap Discussed

Why choose a value chain because the value chain applies to all stakeholders involved, it can be qualitative or quantitative. The value that is highlighted in the agroindustry supply average is the value that is distributed based on transactions that occur from upstream to downstream of the supply chain. Main activities such as sales logistics, services supported by company infrastructure, human resources involved, technology, and procurement. And the application of blockchain technology as a digital architecture can transform the above series of activities. So far, the value favored by consumers on agro-industry products is very low. Therefore, the value brought by blockchain that is transparent and traceable can add to the competitive advantage of agricultural products.

Discussion

The supply chain is a challenging system with the condition of our country, which is vast and archipelagic, so it is quite fragmented. The distribution of product, financial, and information data is very difficult to validate accuracy. In addition, recording is still simple, a centralized computer network is far from ideal conditions of transparency, honesty, and immutability.

The accuracy of distribution data that occurs along the supply chain can be validated by the blockchain, with immutable characteristics making the data and information that has been inputted cannot be changed back so that transparency and honesty to trustworthiness along the distribution channel of goods, money and data information are accurate. In addition, all stakeholders involved can access existing information, so that product travel history, money, and data can be monitored. Conditions in the field, manufacturers do not know where the product ends up. Only certain parties can access supply chain data to find out complete historical information from upstream commodities to downstream consumers.

The transparent nature of the blockchain in the supply chain also makes it easier to track the form of transactions for additional data. Product transfer information, finance, and information along the distribution channel to the consumer's desk, because so far the distribution of data information flow is very vulnerable to human error, manipulated by irresponsible parties, and is also prone to delays in data entry and validation. There are many challenges in integrating and coordinating stakeholders in the supply chain [46].

The advantage of blockchain is that it can identify the values that arise in transactions that occur within and between stakeholders in an ecosystem. Companies that implement blockchain can reduce costs and risks by automating, tracking, authenticating, and verifying and validating data transaction flows.

Blockchain technology-based supply chains can increase the visibility and documentation of logistics information

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transactions, in addition to reducing costs and risks based on information technology and digitization in data tracking systems, so that consumers can see the transaction journey of quality, quantity and product prices transparently. It is hoped that blockchain technology can take advantage of verification and digitization of data safely which can increase consumer loyalty.

4. Conclusion

Agroindustry in the supply chain involves the movement of products, information, and finance from upstream to downstream. Today's supply chain processes are surrounded by a lack of security, transparency and accountability. Blockchain can be used as part of a system that generates visibility and trust in the supply chain.

The decentralized blockchain approach is expected to change the perspective of the global supply chain as diversity in the current pandemic and technology era 4.0. By optimizing stakeholders so that even distribution of welfare can be achieved. The application of blockchain in the value chain that occurs along the supply chain is expected to improve the performance of the agroindustry supply chain which is still less than optimal. With transparency and traceability of the distribution of data transactions that occur, be it the flow of product, financial, or information transactions.

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