



# The Status of Technology Use in Supply Chain Management in the Tea Sector in Kenya

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## Abstract

The tea industry in Kenya is a critical component of the national economy, yet traditional supply chain management faces significant challenges, including inefficiencies, lack of transparency, and limited stakeholder trust. These issues lead to problems such as fraud, counterfeiting, and payment delays, adversely affecting the efficiency and profitability of the tea supply chain. This study investigates the potential of blockchain-based smart contract technology to enhance transparency, data management, and security within the Kenyan tea supply chain. The research aimed to develop and validate a blockchain-based smart contract model tailored for the tea sector. The objectives included: (1) assessing the current state of supply chain management in the tea industry, (2) exploring blockchain's unique features that can improve supply chain management, and (3) identifying key factors influencing the adoption of blockchain technology in this context. Employing a pragmatist research philosophy and a cross-sectional survey design, the study focused on both multinational and KTDA-owned tea companies. A mixed-method approach was used, collecting data from 754 employees, with a sample size of 156. Quantitative data were analysed using descriptive and inferential statistics, while qualitative data were examined through thematic analysis. Findings indicated significant relationships between various constructs and blockchain smart contracts: ICT infrastructure ( $\beta = .488$ ,  $p = .040$ ), data integration and automation ( $\beta = .970$ ,  $p = .047$ ), collaboration ( $\beta = .843$ ,  $p = .036$ ), and security/privacy ( $\beta = .105$ ,  $p = .022$ ). The developed blockchain smart contract model serves as a foundation for implementing this technology in Kenya's tea supply chain, guiding future research on blockchain adoption across different industries.

## Introduction

The tea industry in Kenya plays a vital role in the country's economy, ranking among the world's leading tea exporters. With a rich heritage in tea cultivation and production, the sector comprises a complex network of stakeholders, including tea growers, small-scale farmers, processing factories, exporters, and retailers, working collaboratively to ensure the production and distribution of high-quality tea products.

Supply chain management (SCM) plays a vital role in the tea sector by coordinating and integrating various activities throughout the supply chain, including production, processing, packaging, and distribution. Effective SCM practices are essential for optimising inventory management, minimising lead times, and enhancing customer satisfaction (Charles, 2018). Moreover, SCM addresses sector-wide challenges such as quality assurance, sustainability, and global market competitiveness.



Despite notable progress, the Kenyan tea sector continues to face persistent challenges. The industry relies heavily on outdated supply chain management methods, particularly manual record-keeping and paper-based documentation. This reliance results in significant information gaps, making it difficult for stakeholders to ensure transparency, traceability, and timely decision-making across the supply chain. Consequently, inefficiencies such as delays, increased costs, and decreased customer satisfaction continue to hinder operational performance and the sector's ability to meet regulatory requirements and dynamic market demands.

Given the complexity and scope of the tea supply chain, it is essential to explore technological innovations that can address these inefficiencies. One such promising solution is blockchain technology, which offers potential for enhancing transparency, data integrity, and real-time tracking across the supply chain.

### Overview of Supply Chain Management

The term "supply chain" refers to the entire process, which includes the actual and associated data movement of money, goods, information, and raw materials. It impacts the performance of businesses and plays a special and crucial function (Maouchi, Ersoy, & Zekeriya, 2018). The supply chain or store network oversees or is engaged with sourcing, acquisition, assembly, circulation, and coordination, influencing speed-to-market, product cost, product discernment, and organisational capital requirements (Maouchi, Ersoy, & Zekeriya, 2018). Store network incorporates divided and regularly geographically discrete cycles into a durable framework to convey value to the client. The centre capacities and tasks of a shared inventory network are represented in Figure 1.

Source: (Maouchi, Ersoy, & Zekeriya, 2018)

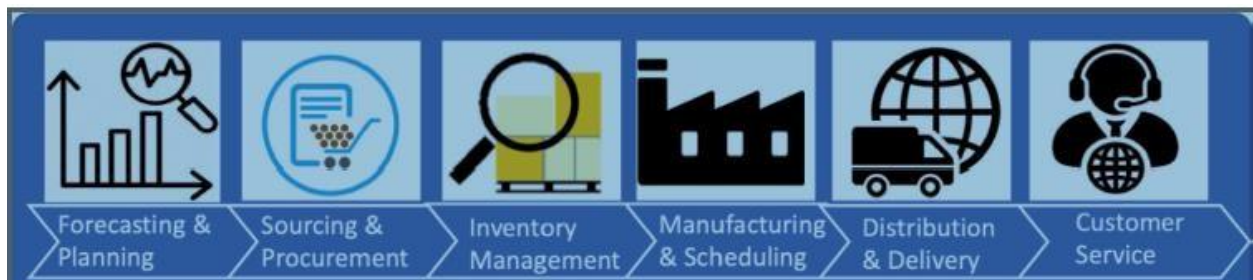


Figure 1: Supply Chain and Operation

### Key Challenges of the supply chain

The current supply chain landscape is characterised by evolving customer requirements, competitive challenges, geographical dispersion, and emerging new business models such as e-commerce. The widespread adoption of e-commerce and handheld digital devices has revolutionised consumer behaviour, particularly in shopping (White, Afolayan, & Plant, 2014). Customers now have a growing demand for personalised products, streamlined shopping experiences, and transparency regarding the value and origins of goods (White, Afolayan, & Plant, 2014). While these changing customer needs create business opportunities, they pose significant challenges to existing supply chains. Outdated supply chains struggle to effectively manage demand, provide end-to-end data visibility, and track goods from raw materials to end consumers. This complex process is further compounded by the limitations of current technologies, which hinder adequate risk management, cost reduction, and the ability to adapt to rapidly changing market requirements.

*Lack of traceability:* The importance of traceability in the supply chain has significantly increased over the last decade, particularly in customer service, business operations, forecasting and planning (Maouchi, Ersoy, & Zekeriya, 2018). However, implementing a centralised system in an



interconnected network is challenging due to limited trust among participants. Each party in the supply chain maintains discrete systems with their databases for product tracking throughout the process, further complicating traceability efforts (Maouchi, Ersoy, & Zekeriya, 2018).

*Stakeholder distrust:* The lack of trust among stakeholders poses a significant challenge in supply chain management (Tyndall, 1998). Trust forms the fundamental basis for a strong and effective supply chain network (Poirier, 1999). When participants lack trust in one another, it becomes a significant setback for the entire supply chain network and hinders efforts to improve its functioning. As a result, stakeholders often rely on intermediaries, such as agents, to facilitate transactions and mitigate trust-related issues. However, this reliance on intermediaries increases operational costs and reduces overall network efficiency.

*Limited transparency:* The term "transparency" in the context of supply chain management refers to the degree to which stakeholders have access to accurate and sufficient information about products (Deimel, Frentrup, & Theuvsen, 2008; Pant, Prakash, & Farooquie, 2015). Transparency builds stakeholder trust and ensures data integrity and product quality. However, the supply chain lacks transparency, as valuable information is often lost during stakeholder transfer. This is compounded by paper-based documentation, leading to inconsistencies and inadequate interoperability. Despite significant research investments, these critical challenges persist. The Chipotle Mexican Grill case is a notable example of the inefficiency and potential inability of the current supply chain system to provide transparency throughout the entire product lifecycle (Kshetri, 2018).

*Outdated means of data sharing:* In today's supply chain network, information is exchanged among many businesses through paper-based documentation (Chang & Iakovou, 2019). Bills of lading, letters of credit, invoices, insurance policies, and numerous certificates are required to accompany their linked products globally. In 2014, Maersk, a significant transportation and logistics company, had to manage nearly 200 conversations to complete a single cargo of frozen goods from Mombasa to Europe (Allison, 2016). These communications resulted in a stack of paperwork around 25 centimetres high. However, this archaic and inefficient information-sharing approach frequently causes delays in ports when the paperwork does not coincide with the real delivered cargo.

*Compliance challenges:* Companies must now follow increasingly severe regulatory standards to provide their customers safe products and services. In recent years, the United States Food and Drug Administration and the Federal Trade Commission have introduced several laws to improve food safety and provide complete visibility of food flows across the supply chain. However, current supply chain procedures make collecting this information from numerous stakeholders difficult and creating a database that meets the new standards (Applicature, 2018).

### **Technological Advancements of Supply Chain Management Systems**

The decentralised network known as blockchain is the foundation of smart contracts. Smart contracts use blockchain technology to check, verify, and enforce agreements agreed upon by many parties. Smart contracts enable anonymous individuals to conduct transactions without requiring a central body, external enforcement, or legal system (Meijer, 2020). These transactions are visible, traceable, and irreversible since they can be monitored via the blockchain. The immutability and security of blockchain make it an ideal platform for smart contracts, as all stored information is encrypted and recorded in a ledger, ensuring it cannot be tampered with through editing or deletion (Meijer, 2020).

Financial services, in particular, have rapidly embraced blockchain technology, primarily influenced by the earlier success of Bitcoin as a blockchain implementation. To test and trial projects involving blockchain technology for share trading on the Nasdaq Private, Nasdaq and OMX Group Inc. collaborated with the blockchain startup Chain in 2015 (Laura, 2015). Furthermore, prominent organisations including RBS, Visa Europe, the Commonwealth Bank of Australia, and several high



street banks in the UK have all declared that they are working on blockchain proof-of-concepts (Rizzo, 2015; Caffyn, 2015 & Cuthbertson, 2015).

With blockchain technology and smart tagging, mobile technology has been implemented to track fish caught in fishing areas while verifying sustainability claims. The primary objective was to establish verifiable proof of compliance with standards at the origin and throughout the supply chain, aiming to prevent the duplication of certificates. Furthermore, the objective was to investigate the potential of these developing technologies in establishing a transparent and open food and other physical items traceability system (Mohd et al., 2021). Throughout the export chain, the experimental project effectively tracked responsibly caught fish and significant social claims. The use of provenance information aimed to address the need for data interchange and interoperability in tracking various items from end-to-end, without relying on a centralised data management system. The research findings revealed that blockchain technology met these requirements and presented an exciting paradigm for traceability (Mohd et al., 2021).

Blockchain technology tracks and verifies physical goods' flow and confirmed qualities from the point of sale (POS) to their origin via mobile and smart tags. The first known use of blockchain technology was in the well-known peer-to-peer (p2p) Bitcoin payment system. On May 22nd, 2010, Laszlo Hanyecz transacted with another Bitcoin user, exchanging 10,000 BTC for two Papa John's pizzas. This transaction occurred online without the involvement of traditional financial institutions like Visa or PayPal (Lazlo, 2010). On May 22, 2016, six years later, Provenance used the same peer-to-peer technology to track a tuna fish caught in Maluku, Indonesia, from the landing site to the factory and back. This demonstrated how supply chains might benefit from blockchain technology's potential to promote traceability and transparency (Mohd et al., 2021).

As blockchain technology continues to gain attention, numerous companies and startups are exploring its applications beyond the financial services sector. Many organisations conduct experiments and pilot projects to leverage blockchain technology for various purposes (Chege et al., 2017). For example, Provenance, a business focusing on supply chain transparency, just finished a successful six-month pilot programme using blockchain technology to track ethical tuna sourcing in Indonesia. Furthermore, a 2014 startup, Monograph, uses blockchain technology to enable income sharing between media artists, publishers, and distributors while securing usage and sharing rights for digital media property like video clips and brand-sponsored content (KTDA, 2022).

With a reported 444 million mobile subscribers in sub-Saharan Africa, as stated by the Groupe Speciale Mobile Association (GSMA) in 2017, the potential for both large-scale and small-scale farmers to adopt blockchain technology is within reach. (GSMA, 2022). However, internet connectivity is necessary to record farmer transactions on the blockchain ledger. In 2017, only 38% of internet users in the region had access to mobile broadband (GSMA, 2022). While infrastructure limitations exist, there is optimistic progress towards improvement. By 2025, it is estimated that more than two-thirds (87%) of mobile users in sub-Saharan Africa will have internet connectivity (GSMA, 2022).

### **Methodologies**

This study employed a mixed-methods design using a pragmatic approach, integrating quantitative and qualitative data collection strategies. A cross-sectional survey targeted 758 individuals, including tea farmers and factory managers, from KTDA-managed and private factories. A sample size of 225 respondents was determined using stratified random sampling to ensure diverse representation across smallholder farmers, large-scale manufacturers, and KTDA management. Structured questionnaires were administered to assess current technology use and perceived benefits, complemented by in-depth interviews with key stakeholders, such as KTDA officials and factory managers, to gain richer insights into operational practices. For data analysis, statistical methods were



applied to the quantitative responses using SPSS to identify trends and correlations. In contrast, qualitative data underwent thematic analysis to extract common themes and insights from the interviews. Ethical considerations were rigorously followed, ensuring informed consent and participant confidentiality throughout the study.

### **Response rate**

Table 1 presents the response rate of participants from various companies, categorised as Buyers, Farmers, Sales Representatives, Factory Management, and ICT Officers. The overall response rate was 89%, which Fincham (2008) considers a good representation, as any rate above 70% is acceptable.

*Table 1: Summary of Response Rate*

<b>Company</b>	<b>Buyers</b>	<b>Farmers</b>	<b>Sales Reps</b>	<b>Factory Management</b>	<b>ICT Officers</b>
Unilever	34%	26.4%	20%	28%	18.2%
James Finley	27.7%	22.6%	10%	16%	27.2%
KTDA	17%	22.6%	10%	16%	91%
Nandi Tea Estate	4.3%	7.5%	10%	8%	9.1%
DL Koisagat Tea Estate	6.4%	7.5%	10%	8%	9.1%
Kakuzi	4.3%	2%	10%	4%	9.1%
Eastern Produce Kenya Companies	2%	5.7%	10%	8%	9.1%

The sample included 47 Buyers (30.1%), 53 farmers (34%), 25 Factory Management (16%), 20 Sales Representatives (12.8%), and 11 ICT Officers (7.1%). Unilever, James Finley, and KTDA contributed the largest percentages, indicating larger populations in these companies than others. Notably, there were fewer ICT Officers and management officials across all firms, suggesting that the findings primarily reflect the views of farmers, Buyers, and Sales Representatives who interact more frequently with the system.

### **Adoption of Blockchain Platform in the Tea Supply Chain**

The respondents varied in opinion on adopting a blockchain platform in the tea supply chain, but generally felt it was a good idea. 77.4% agreed that there should be a blockchain-based transparency model using smart contracts in the tea supply chain management, only 15.5% disagreed, while 7.1% were neutral. Additionally, 76.2% agreed that the blockchain-based transparency model would improve trust and verification, as 14.8% were unconvinced, while 9% were neutral. When asked about the use of ICT technologies and how it plays a vital role in the supply chain management regarding data sharing, 80.6% affirmed so, 11.6% were noncommittal, and 7.8% disagreed. Furthermore, 79.4% felt that the overall accuracy of supply chain management will improve once the smart contract blockchain-based is in place, 7.7% disagreed, and 12.9% remained neutral.

Regarding the duplication during the generation and recording of data once the blockchain model is implemented, 36.9% agreed, 49.1% disagreed, and 14% were noncommittal. When asked about the need to adopt a common data identifier while recording the farmers' data, 77.4% approved the idea, 12.3% did not, and 10.3% stayed neutral. These findings relate to Gong & Brown (2023), who also indicated that seamless integration and automation are not achievable using the current technology without proper configuration of any automated process. This implies that end-to-end automation indeed affects the processes.

Most respondents (77.4%) agreed there should be a blockchain-based transparency model using smart contracts in the tea supply, compared to 15.5% who disagreed. This implies that in the current state, there is no transparency in the operations of technologies that are applied to manage the supply chain process. Furthermore, most respondents (80.6%) agreed that ICT is vital in supply chain management and enables data sharing. This implies that efficient and reliable technologies should be integrated in managing tea supply processes. This finding is supported by the findings of Gupta (2023).



### **Technological Infrastructure**

Regarding the constraints of technological infrastructure, the respondents mostly agreed with all the questions. 79.4% of them felt that the current technological structure is inadequate for blockchain; the current internet service is not efficient enough for blockchain; and there is insufficient access to blockchain technology. Contrary to the finding by Halldorsson & Kotzab (2007), about 12.9% disagreed, while 7.7% were neutral. When visually represented, the above data clearly shows that the users of the current technological structure, internet services, and access to blockchain technology are inadequate for integrating blockchain to manage tea supply processes.

### **Compatibility**

On compatibility, 74.2% disagreed that blockchain technology is incompatible with their work, operations, business processes, and other information systems (e.g., ERP, MIS, and WMS). On the contrary, 10.4% agreed with the statement, as 15.4% remained neutral. Regarding scalability, 83.9% felt that the overall speed and block size of transactions (7 transactions per second) on blockchain are not excellent for practical use; 3.2% agreed with the question statement, as 12.9% remained noncommittal. Regarding complexity, 57.4% disagreed with the statement that blockchain is conceptually complex to understand from a business and technical perspective, and to resolve transactional errors; however, 32.3% were neutral, and 10.3% agreed. Regarding the security of the blockchain-based technology, 71.6% of respondents did not agree that it is secure in providing, sending, and uploading sensitive information related to the company, and when operating a business with sensitive information overall. On the other hand, 16.1% were not committed, as the other 12.3% agreed.

The results above imply a technological gap between the technologies used in tea processing companies and the required technology to manage blockchain processes, as demonstrated by 74.2% of the respondents. The result further implies that blockchain is challenging to understand. Therefore, there is a need to train users, especially the key stakeholders involved directly with the processes affecting farmers and Sales Representatives, who form the largest population of the users as per the current sample investigated.

### **Exploratory Factor Analysis**

Exploratory factor analysis (EFA) was used to assess the nature and patterns of constructs and reduce the number of factors making up each set of latent variables. The extraction method used was Principal Component Analysis (based on getting factors strongly correlated with each other), while Varimax was the rotation method. The eigenvalue (the amount of variance each factor accounts for) was used to extract factors for all the constructs. Values greater than one are stable and good to use in analysis. Furthermore, Bartlett's test and Kaiser-Meyer-Olkin (KMO) were performed to check the data's suitability for all constructs. KMO values nearer to one show that the data is suitable for factor analysis (FA). The latent variable ICT infrastructure had five factors: Network connection, Transaction Systems, System Architecture, Database Systems and Blockchain Hosting Platforms, which were coded as CT1, CT2, CT3, CT4, and CT5 (see Appendix C, Section C). Their eigenvalues were 1.247, 1.085, 1.051, .867, and .750, respectively; thus, CT1, CT2, and CT3 were extracted for use in the analysis. Additionally, KMO for the factors under this construct was .780, significant at  $p < 0.05$  for a 95% confidence level.

### **Extraction Method: Principal Component Analysis**

The latent variable data integration and automation had nine factors: recorded as D1, D2, D3, D4, D5, D6, D7, D8 and D9. Their eigenvalues were 2.972, 2.284, 1.118, 1.037, .676, .425, .230, .225, and .032, respectively; thus, D1, D2, D3, and D4 were extracted for use in the analysis. Likewise, KMO for the factors under this construct was .685, significant at  $p < 0.05$  for a 95% confidence level. The findings of the analysis are shown in Table 2 below.



Table 2: Data Integration Factors

Component	Eigenvalue	Extraction	Variance	Cumulative
D1	2.972	2.972	33.019	33.019
D2	2.284	2.284	25.383	58.401
D3	1.118	1.118	12.426	70.828
D4	1.037	1.037	11.527	82.355
D5	.676			
D6	.425			
D7	.230			
D8	.225			
D9	.032			

Table 3: KMO and Bartlett's Test for Data Integration Factors

Extraction Method: Principal Component Analysis

Table 4: KMO and Bartlett's Test for Data Integration Factors

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.685
	Approx. Chi-Square	835.253
Bartlett's Test of Sphericity	Df	36
	Sig.	.000

The recorded latent collaboration variable had five factors: CO, CG, CR, CC, and CK. Their eigenvalues were 1.981, 1.442, 1.068, .543 and .266; therefore, CO, CG, and CR were extracted for analysis. Likewise, KMO for the factors under this construct was .604, significant at  $p < 0.05$  for a 95% confidence level. This finding supports Torresen (2020), who indicated that data integration ensures accurate and verifiable records of all transactions using blockchain technology. This way, there is improved transparency, security, and integrity of information. Similarly, Pearson and May (2019) indicate that peer-to-peer integration of blockchain subsystems is achievable if the integration is done with an underlying encryption of sub-network applications; they further indicate that this allows expansion of individual blocks in a chronological manner, which is similar to the SEM results of the present study.

### Qualitative Findings from the Study

#### *Qn. How would you describe the complexity of your organisation's tea supply chain?*

Most respondents agreed that the tea supply chain of the organisation now has a moderate complexity, in which there is a mix-up of those who correctly understand the whole process and those who still do not know about proper implementation. Furthermore, they cited that the process of tea supply is choked by middlemen who are relentless in ensuring that they get their cut from the farmers and suppliers. One respondent stated that:

*"The whole idea of the supply chain at the moment is complex, given that several middlemen interfere with the entire process, creating a complexity in handling the entire process. There is a need to automate the process so that farmers and company owners do not have to suffer at the hands of the middlemen, thereby averting the losses."*

*Qn. Have you ever encountered any problems caused by information systems? (For example, providing inaccurate data, etc.)*



Whether or not the ICT officers encountered any problems caused by the information systems, most of the respondents interviewed revealed that they occasionally experienced problems with the information systems. These are often caused by power outages or fluctuating internet connectivity. This eventually affects the process of using the systems effectively, especially when they are most needed.

***Qn. Do you think there is a need to improve the supply process? Why?***

Furthermore, the respondents iterated that there is a need to improve the supply chain process since there is still no complete automation of all the processes involved in the tea supply. The other reason for the need to enhance the supply process was that most stakeholders suffer losses in the current process, and this also calls for the automation of the whole process since it is difficult for the farmer to track the stages of the supply process unless they make either direct phone calls or wait to be notified on the prevailing circumstance with their produce. The middlemen can then find the opportunity to tamper with the process before it is finalised.

## **Part 2: Blockchain-based Transparency model using smart contracts for tea supply chain management questions.**

***Qn. How do you think this blockchain system will benefit your company operations?*** (For example, the transparency in your supply chain, the management of suppliers, the amount of paperwork, etc.)

In responding to this question, respondents cited that:

*“Using a blockchain system will help most suppliers track the products from when they acquire the raw tea, when it is produced, to the final product, and when it is dispatched from the company to the customers. It will help confirm the arrival of dispatches by the company document since the ERP is linked to mobile devices where the customers can validate whether the product received tally with the tea arrival labels on the mobile system.”*

The farmers can also track their tea and even know when the product payment is made. This is consistent with the literature from several studies (Azaria, et al., 2016; Adrien, 2020).

***Qn. What experience and skills do you possess about blockchain technology?***

Most respondents agreed that they rely on the education and training provided by the company to be able to handle the blockchain systems. In a blockchain framework, every information block is distinguished by a hash encryption work and communicates with different squares, forming information blockchain (Carlo, 2020). Likewise, the blockchain innovation lessens the role of middlemen who cause interruptions, hacking, and extortion. When the Blockchain innovation is utilised, trust in the organisation and its tasks is expanded (Buterin, V., Dziembowski, S., Zohar, A., & Leverj, A, 2017).

***Qn. Have been involved in a project with blockchain technology?***

Most respondents also indicated that they have been involved in projects implementing blockchain technology and that most of them rely on on-the-job implementation of the technology to enable them to use it successfully.

***Qn. Do you have any other good examples of successful projects?***

Regarding whether they have any other good examples of successful projects, they indicated that several projects have been done by the companies to help moderate the tea supply process and track other processes that the company is involved in.

***Qn. What possibilities do you see with blockchain?***



In responding to this, one respondent indicated that;

*“The whole process of blockchain technology will help all the company processes and also help reduce the wage bill of payments made to middlemen and unnecessary losses. We, as the IT people, will also benefit greatly since we will have a properly coordinated system helping to manage all the processes at a glance.”*

### **Conclusion**

The study reveals that the status of technology use in supply chain management within Kenya's tea sector is significantly influenced by several factors, including the efficiency of ICT infrastructure, effective data integration among stakeholders, and robust collaboration among organisations. The findings emphasise that while challenges such as high implementation costs and the need for supportive government policies persist, the potential for improved efficiency and reduced long-term costs makes adopting advanced technologies like blockchain essential. Thus, fostering collaboration and addressing infrastructural shortcomings will be critical in enhancing the technological landscape of the tea supply chain.

### **References**

- Adrian, T., & Mancini-Griffoli, T. (2023, February 23). *Technology Behind Crypto Can Also Improve Payments, Providing a Public Good*. International Monetary Fund:
- Adrien, B. (2020, December 22). *How To Choose The Right Blockchain Technology | by Conor | Web3 Labs*.<https://medium.com/web3labs/how-to-choose-the-right-blockchain-technology-724b3b7ef6ae>
- Allison, I. (2016, October 12). Reducing Trade Costs through Automation: The Role of the WTO. *World Trade Review*, 191-211. IBTimes UK: <https://www.ibtimes.co.uk/shipping-giant-maersk-tests-blockchain-powered-bills-lading-1585929>
- Azaria, A., Ekblaw, A., Vieira, T., & Lippman, A. (2016). MedRec: Using Blockchain for Medical Data Access and Permission Management. In *2016 2nd International Conference on Open and Big Data (OBD)* (pp. 25-30). IEEE.
- Buterin, V. (2015). A Next Generation Smart Contract & Decentralized Application Platform. <http://people.cs.georgetown.edu/~clay/classes/fall2017/835/papers/Etherium.pdf>
- Buterin, V., Dziembowski, S., Zohar, A., & Leverj, A. (2017). Smart Contracts: Formalization and Applications. Retrieved from <https://ssrn.com/abstract=3000482>.
- Chang, Y., & Iakovou, E. (2019, August 11). Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities. *International Journal of Production Research*, 58(7), 2082-2099.
- Charles, K. (2018). Challenges of entering new international markets by exporters of Kenyan tea; a case study of selected tea exporters. Unpublished master's thesis, Juja: JKUAT-Kenya.
- Chege, P., Ngugi, P., & Ngugi, J. (2017). Influence of internal business value chain practices on the supply chain performance of large manufacturing firms in Kenya. Unpublished PhD Thesis. Juja, Nairobi: JKUAT Kenya.
- Deimel, M., Frentrup, M., & Theuvsen, L. (2008). Transparency in food supply chains: empirical results from German pig and dairy production. *Journal on Chain and Network Science*, 8(1), 21-32. Retrieved from <https://www.wageningenacademic.com/doi/10.3920/JCNS2008.x086>
- Gong, Y., & Brown, S. (2023). *Blockchain Applications in Food Supply Chain Management: Case Studies and Implications*. Springer Nature Switzerland.
- GSMA. (2022, October 19). Mobile Internet's 'Usage Gap' is Almost Eight Times the Size of the 'Coverage Gap', GSMA Research Reveals.
- Gupta, S. (2023). Challenges and Opportunities in Tea Supply Chain Management: A Case Study of the Kenyan Tea Sector. *International Journal of Supply Chain Management*, 3, 135-150.



- Hackius, N., & Petersen, M. (2017, October 1). Blockchain in logistics and supply chain : trick or treat? *Proceedings of the Hamburg International Conference of Logistics*, 23, 3-18.
- Halldorsson, A., & Kotzab, H. (2007, June 26). Complementary theories to supply chain management. *Supply Chain Management*, 12(4), 284 - 296.
- Kshetri, N. (2018, April). 1 Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, 39, 80-89.
- KTDA (2017) Kenya Tea Development Agency Background. Available at: <http://www.ktdateas.com> accessed on 16/07/2023
- KTDA, (2022). Kenya Tea Development Agency Report on tea production. Nairobi: Kenya Tea Development Agency Publications.
- Laura, S. (2015, June 24). *Nasdaq Selects Bitcoin Startup Chain To Run Pilot In Private Market Arm*. Forbes: <https://www.forbes.com/sites/laurashin/2015/06/24/nasdaq-selects-bitcoin-startup-chain-to-run-pilot-in-private-market-arm/?sh=b07bd8683d58>
- Maouchi, M. e., Ersoy, O., & Zekeriya, E. (2018, May). TRADE: A Transparent, Decentralized Traceability System for the Supply Chain. *Proceedings of 1st ERCIM Blockchain Workshop 2018*.
- Meijer, C. R. (2020, September 30). *Smart working with blockchain-based smart contracts*. Retrieved May 25, 2021, from Finextra Research: <https://www.finextra.com/blogposting/19383/smart-working-with-blockchain-based-smart-contracts>
- Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shahbaz Khan, Rajiv Suman. (2021). Blockchain technology applications for Industry 4.0: A literature-based review. *Blockchain: Research and Applications*, 2(4). <https://doi.org/10.1016/j.bcra.2021.100027>
- Mohd Javaid; Abid Haleem; Ravi Pratap Singh; Shahbaz Khan; Rajiv Suman. (2021). Blockchain technology applications for Industry 4.0: A literature-based review,. *International Journal of Advanced Science and Technology*, 30(8), 407-420.
- Pandey, V., Pant, M., & Snasel, V. (2022, May). Blockchain technology in food supply chains: Review and bibliometric analysis. *Technology in Society*, 69.
- Pant, R. R., & Prakash, G. (2015, May 15). A Framework for Traceability and Transparency in the Dairy Supply Chain Networks. *Procedia - Social and Behavioral Sciences*, 189, 385-394.
- Pant, R. R.; Prakash, Gyan; Farooquie, Jamal A. (2015). A Framework for Traceability and Transparency in the Dairy Supply Chain Networks. *Procedia - Social and Behavioral Sciences*, 189, 385-394.
- Pearson, S., & May, D. (2019, March). Are Distributed Ledger Technologies the panacea for food traceability? *Global Food Security*, 20. <https://doi.org/10.1016/j.gfs.2019.02.002>
- Poirier, C. C. (1999). *Advanced Supply Chain Management: How to Build a Sustained Competitive Advantage*. Berrett-Koehler Publishers.
- Rizzo,2015; Caffyn,2015 & Cuthbertson, 2015. (n.d.). *Why Visa Europe is Testing Remittances on the Blockchain*. CoinDesk: <https://www.coindesk.com/markets/2015/11/25/why-visa-europe-is-testing-remittances-on-the-bitcoin-blockchain/>
- Snell, T. (2018). The use of blockchain in supply chain management: A systematic literature review. *Supply Chain Forum: An International Journal*, 19(1), 20-41. doi:10.1080/16258312.2018.1434284
- Tentama, F., & Anindita, W. D. (2020). Employability scale: Construct validity and reliability. *International Journal of Scientific and Technology Research*, 9(4), 3166-3170.
- TransVoyant. (2018). Blockchain the Newest Technology in Supply Chain Part 1. Retrieved February 9, 2021, from <https://transvoyant.com/blockchain-newest-technology-supply-chain-part-1>
- Tyndall, G. R. (1998). *Supercharging Supply Chains: New Ways to Increase Value Through Global Operational Excellence*. Wiley.
- Using Blockchain to Drive Supply Chain Transparency and Innovation*. (2019). Deloitte <https://www2.deloitte.com/us/en/pages/operations/articles/blockchain-supply-chain-innovation.html>



- White, G. R., Afolayan, A., & Plant, E. (2014). Challenges to the Adoption of E-commerce Technology for Supply Chain Management in a Developing Economy: A Focus on Nigerian SMEs. In *E-commerce Platform Acceptance: Suppliers, Retailers, and Consumers* (pp. 23-39). Springer International Publishing.
- Yadav, S., & Singh, S. P. (2020b). An integrated fuzzy-ANP and fuzzy-ISM approach using blockchain for sustainable supply chain. *Journal of Enterprise Information Management*, 34(1), 54-78.
- Zhao, G., & Liu, S. (2019, August). Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. *Computers in Industry*, 109, 83-99.