The Effect of Blockchain Technology in Enhancing Ethical Sourcing and Supply Chain Transparency: Evidence from the Cocoa and Agricultural Sectors in Ghana

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ABSTRACT

This study examines the impact of blockchain technology on ethical sourcing and supply chain transparency in Ghana's cocoa and agriculture industries. Using the Diffusion of Innovation Theory as a framework, the study investigates the adoption and influence of blockchain technology on ethical sourcing practices and supply chain transparency. Regression analysis was conducted using data from 153 firms in the agricultural and cocoa sectors to explore the relationships between blockchain technology usage, ethical sourcing, supply chain transparency, adoption of new technologies, and corporate social responsibility. The results highlight the significant influence of blockchain technology adoption on supply chain transparency and ethical sourcing practices in the cocoa and agricultural sectors. Specifically, companies that utilize blockchain technology tend to have more transparent supply chains and are more likely to engage in ethical sourcing compared to those that do not. Moreover, there is evidence suggesting that the use of technology, particularly blockchain, is a strong predictor of increased transparency, with positive correlations observed across all industries. These findings illustrate the potential of blockchain technology to enhance ethical sourcing methods and supply chain transparency in Ghana's cocoa and agriculture industries. It is recommended that both public and private corporations consider investing in technology adoption, particularly blockchain technology, as it has the potential to improve ethical sourcing practices.

Keywords: Blockchain, Cocoa and Agricultural Sectors, Ethical Sourcing, Supply Chain, Technology, Transparency

I. INTRODUCTION

Ghana's economic engine hums on the pistons of its agriculture and cocoa sectors. These industries are the lifeblood of countless communities, a source of national pride, and a significant contributor to foreign exchange (Adu-Gyamfi & Boateng, 2019). However, a shadow hangs over this prosperity: the persistent issues of unethical sourcing and a lack of transparency within the supply chain (Salih & Mhlanga, 2023). These challenges not only threaten the reputation of Ghanaian agriculture and cocoa but also hinder their potential for growth and sustainability.

On this backdrop, blockchain technology emerges as a beacon of hope. Unlike traditional methods of record-keeping, blockchain offers a revolutionary approach (Salih & Mhlanga, 2023). It is a decentralized and distributed digital ledger that permanently records and makes every transaction visible to all authorized participants. Owusu-Ansah and Asamoah (2018) assert that the inherent immutability of blockchain ensures the authenticity and integrity of information throughout the supply chain, preventing any tampering. Blockchain excels in traceability; every step a product takes, from the farm where the cocoa bean is harvested to the processing facility and ultimately the store shelf, can be meticulously tracked on the blockchain (Adu-Gyamfi & Boateng, 2019). This empowers consumers to trace the origin of their cocoa products, verify ethical sourcing practices, and ensure fair compensation reaches the farmers who deserve it. Blockchain fosters trust within the supply chain ecosystem (Amegashie-Duvon, 2014). By eliminating the need for intermediaries and creating a shared, verifiable record, all stakeholders—farmers, processors, exporters, and retailers—can operate with greater confidence. This fosters collaboration, reduces the risk of fraud, and ultimately benefits everyone involved (Adu-Gyamfi & Boateng, 2019).

In the context of Ghana's agricultural and cocoa industries, blockchain's potential to address ethical sourcing concerns is particularly significant (Amegashie-Duvon, 2014). Globally, consumers are progressively demanding products sourced ethically and produced using responsible practices. Blockchain allows stakeholders to demonstrate

compliance with fair trade and sustainability standards, providing verifiable proof that Ghanaian cocoa is produced ethically and that farmers are adequately compensated for their labour (Adu-Gyamfi & Boateng, 2019). This transparency translates to a competitive advantage for Ghanaian products in the global marketplace (Amegashie-Duvon, 2014). The benefits extend beyond just reputation. By providing a clear picture of the supply chain, blockchain empowers stakeholders to identify inefficiencies and bottlenecks. This newfound transparency allows for targeted interventions to improve efficiency, reduce waste, and ultimately increase profitability (Adu-Gyamfi & Boateng, 2019).

1.1 Research objective

This study examines the potential benefits of blockchain technology for ethical sourcing and supply chain transparency in Ghana's agriculture and cocoa sectors.

II. LITERATURE REVIEW

2.1 Theoretical Foundations

The Diffusion of Innovation Theory (Rogers, 2003) provides a strong theoretical framework for this inquiry. This theory examines the factors that influence the adoption and spread of innovations in social systems. Rogers (2003) proposes that the Diffusion of Innovation Theory posits the acceptance of new technologies through five stages: knowledge acquisition, persuasion, decision-making, implementation, and confirmation. In this article, we use this theory as a lens to explore the adoption and integration of blockchain technology in Ghana's cocoa and agriculture sectors. We specifically focus on the impact of blockchain technology on ethical sourcing and supply chain transparency. In the early stages of the diffusion process, it is important for individuals working in Ghana's agriculture and cocoa sectors to understand blockchain technology and its potential to enhance supply chain transparency and accountability. During this stage, various channels like conferences, workshops, and educational resources disseminate information about blockchain (Davis et al., 1989).

After information comes to the stage of persuasion, people evaluate the idea based on its alleged advantages and disadvantages. Researchers and legislators must persuade stakeholders of the benefits of blockchain technology for enhancing ethical sourcing and transparency. Studies demonstrating blockchain's successful implementations in other fields or industries can provide compelling evidence for the technology's potential advantages (Rogers, 2003). A portion of the decision-making process involves approving or disapproving the invention. Important decision-makers in Ghana's cocoa and agriculture sectors now need to weigh the benefits, drawbacks, and risks of implementing blockchain technology.

The decision-making process for implementing blockchain technology is influenced by various factors, such as institutional support, technical readiness, and financial resources (Rogers, 2003). The decision to use blockchain technology initiates the implementation phase, which involves integrating the technology into the operational processes and infrastructure of the supply chain. Challenges may arise during implementation, such as user acceptance, data standards, and interoperability, which require careful planning and collaboration (Rogers, 2003). The adoption process is complete at the confirmation stage. It entails projecting blockchain technology adoption and assessing its long-term impact on ethical sourcing and supply chain transparency. This stage includes monitoring key performance indicators, gathering feedback from stakeholders, and making adjustments to enhance the effectiveness of blockchain solutions (Davis et al., 1989).

2.2 Empirical review

2.2.1 Block Chain Technology, Ethical Sourcing, and Supply Chain Transparency

There has been growing interest in exploring the potential of blockchain technology to enhance supply chain transparency and ethical sourcing, specifically in Ghana's agriculture and cocoa sectors. Numerous research studies have investigated the application of blockchain to understand how it can improve accountability, transparency, and traceability throughout the supply chain (Bai et al., 2022; Musah et al., 2019; Kraft & Kellner, 2022; Mathew, 2020; Salih & Mhlanga, 2023; Amegashie-Duvon, 2014; Kamilaris et al., 2019; Chandan et al., 2023; Mensah et al., 2020).

Adu-Gyamfi and Boateng (2019) examined the application of blockchain technology in Ghana's cocoa industry, highlighting its potential to promote fair trade principles and ensure fair compensation for farmers. The study suggests that blockchain's traceability solutions can significantly reduce fraud and unethical practices in the cocoa supply chain. In terms of traceability and transparency, Musah et al. (2020) found that blockchain technology can improve information flow and mitigate fraud. Quayson (2021) explored how blockchain empowers farmers and enhances income transparency. Both studies acknowledge the benefits of the technology but also recognize challenges

such as scalability issues, limited infrastructure, and digital literacy barriers among farmers. Other research has focused on specific applications. Akoto et al. (2023) investigated a blockchain-based method for tracking cocoa beans from farm to factory, demonstrating how it can enhance traceability and quality control.

Anane et al. (2022) examined the use of blockchain to verify fair labor standards and ethical sourcing in the cocoa supply chain, showcasing its potential for social impact. Despite these positive findings, current research has some limitations. Many studies remain theoretical and conceptual, lacking empirical evidence from real-world implementations. Additionally, there is limited research on the specific challenges faced by smallholder farmers, who play a crucial role in promoting ethical sourcing. Furthermore, there is a lack of study on the long-term effects of blockchain efforts on supply chain dynamics and farmers' livelihoods.

While existing research provides valuable insights into the benefits of blockchain technology, further investigation is needed to address these drawbacks. Specifically, empirical studies are necessary to assess the actual impact of blockchain technology on ethical sourcing practices in real-world settings.Furthermore, prior research has typically overlooked the particular challenges and contextual factors inherent in Ghana's agricultural and cocoa sectors. Although blockchain technology can improve openness and accountability, its successful implementation requires consideration of regional socioeconomic, cultural, and infrastructural factors. The study conducted by Owusu-Ansah and Asamoah (2018) investigated the potential of blockchain technology to enhance transparency in Ghana's agricultural industry. However, the study did not tackle the practical problems associated with digital literacy, internet connectivity, and technological accessibility in remote farming areas.

The objective of the present study is to address the existing gaps in the literature by empirically investigating the impact of blockchain technology on ethical sourcing and transparency within Ghana's agricultural and cocoa industries. To collect reliable empirical data on the actual influence of blockchain technology on local supply chain practices, a mixed-methods approach involving field observations, interviews, and surveys is employed. Furthermore, this study will explore the socioeconomic barriers and infrastructure that may hinder Ghana's successful adoption of blockchain technology, taking into account the contextual factors.

III. METHODOLOGY

The data for the study was obtained from 153 Ghanaian businesses operating in the cocoa and agriculture industries. The information was gathered through the Ghana Enterprise Survey. These businesses were selected based on their involvement in the purchase and sale of fruits and vegetables or cocoa beans. It is worth noting that each of these businesses utilized blockchain technology. The study focused on several key variables, including the use of blockchain technology, supply chain transparency, corporate social responsibility (CSR), ethical sourcing as evaluated through supply chain traceability, and technical adoption. The geographical reach of the firms and the complexity of their supply chains were also measured as continuous variables. The business sizes were classified as small, medium, and large groups according to the Ghana Enterprise Survey. Dummy variables were used for supply chain transparency, corporate social responsibility, ethical sourcing, blockchain technology, and technical adoption in order to facilitate regression analysis. Dummy variables are employed to indicate binary outcomes, such as the presence or absence of specific qualities or behaviors within the organizations being studied. The following empirical models were specified;

$$ETc = a + b_0 CSSBlkChainTech + b_1 CPYsize + b_2 TechAdoption + b_3 GeoReach + b_4 SSChainComplexity + b_5 CSR + b_6 CBlkChainTech + \varepsilon$$

$$SSTc = a + b_0 CSSBlkChainTech + b_1 CPYsize + b_2 TechAdoption + b_3 GeoReach + b_4 SSChainComplexity + b_5 CSR + b_6 CBlkChainTech + \varepsilon$$

$$ETa = a + b_0 ASSBlkChainTech + b_1 CPYsize + b_2 TechAdoption + b_3 GeoReach + b_4 SSChainComplexity + b_5 CSR + b_6 ABlkChainTech + \varepsilon$$

$$SSTa = a + b_0 ASSBlkChainTech + b_1 CPYsize + b_2 TechAdoption + b_3 GeoReach + b_4 SSChainComplexity + b_5 CSR + b_6 ABlkChainTech + \varepsilon$$

While ETc Means ethical sourcing in the cocoa sector, SSTc means supply chain transparency in the cocoa sector, ETa means ethical sourcing in the agriculture sector, SSTa means supply chain transparency in the agriculture sector, $CSSBlkChainTech$ means cocoa sector supply chain technology, $CPYsize$ means the size of a company, $TechAdoption$ means technology adoption, $GeoReach$ means geographical reach as in several countries a company operates in, $SSChainComplexity$ means supply chain complexity, CSR means cooperate social responsibility, $CBlkChainTech$ means cocoa sector blockchain technology and ε is the error term.

The study utilized regression analysis to examine the relationships between the selected variables. Specifically, regression models were developed to investigate the impact of blockchain technology use, ethical

sourcing practices, corporate social responsibility programs, and technological adoption on supply chain transparency within Ghana's cocoa and agriculture industries. In order to evaluate the potential influence of these factors on the dependent variable, the regression models included control variables such as supply chain complexity and geographic reach. The analysis of the regression results revealed significant correlations between the independent and dependent variables.

IV. FINDINGS & DISCUSSIONS

4.1 Findings

4.1.1 Factors Influencing Ethical Sourcing in Ghana's Cocoa and Sectors

Blockchain the cocoa industry's technology (CBlkChainTech) is positively correlated with ethical sourcing methods, with a 47.2% increase in enterprises using blockchain technology compared to those without it (p-value < 0.001). This implies that the adoption of blockchain technology and ethical sourcing are strongly positively correlated.

Additionally, the adoption of technology (TechAdoption) is positively correlated and statistically significant (p-value < 0.001), indicating that organizations that are usually receptive to implementing new technologies are 31.9% more likely to use ethical sourcing practices. This result is presented in Table 1. The finding is consistent with the notion that businesses powered by technology may appreciate ethical behavior.

Nevertheless, there is no conclusive evidence that a company's size, global reach, supply chain complexity, or cooperative social responsibility initiatives are important indicators of ethical sourcing in the cacao sector.

There is no statistically significant correlation (p-value = 0.31) between the size of a corporation and its use of ethical sourcing. The number of areas in which a business conducts business has no impact on ethical sourcing (p-value = 0.784). Additionally, there is no discernible effect from the quantity of supply sources (p-value = 0.813). Furthermore, there is no statistically significant correlation between participating in CSR initiatives and ethical sourcing (p-value = 0.51). This might be the result of several things, including the size of CSR programs and the imperfect monitoring of how they affect sourcing procedures.

Table 1

Linear Regression

CSSChainTrace	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CPYsize	.045	.044	1.02	.31	-.042	.131	
TechAdoption	.319	.095	3.36	.001	.131	.506	***
GeoRearch	-.005	.018	-0.28	.784	-.041	.031	
SSChianComplexity	.006	.024	0.24	.813	-.042	.053	
CSR	.036	.055	0.66	.51	-.073	.145	
CBlkChainTech	.472	.092	5.14	0	.291	.653	***
Constant	-.025	.115	-0.21	.83	-.251	.202	

Mean dependent var	0.467	SD dependent var	0.501
R-squared	0.682	Number of obs	152
F-test	51.924	Prob > F	0.000
Akaike crit. (AIC)	59.645	Bayesian crit. (BIC)	80.812

*** p<.01, ** p<.05, * p<.1

Test of Model fit

According to the R-squared value of 0.682, 68.2% of the variance in ethical sourcing methods can be explained by the model. This is a quite high number, indicating that the model does a good job of capturing the impact of the variables that are included. The model as a whole appears to be statistically significant and has some confidence in its ability to predict ethical sourcing, based on the statistically significant F-test (p-value < 0.000). This result is presented in Table 1. Overall, the findings point to a substantial correlation between the deployment of blockchain technology and ethical sourcing methods in Ghana's cocoa industries. Subsequent studies might examine the underlying processes of this correlation and examine how blockchain technology affects other areas of the supply chain, such as transparency and farmer empowerment.

4.1.2 Factors Influencing Supply Chain Transparency in Ghana's Cocoa and Sectors

The use of technology has a positive and statistically significant association (p-value < 0.001), suggesting that

organizations that are more open to embracing new technologies tend to be 56.4% more transparent than those that are less inclined to do so. This supports the notion that tech-savvy businesses value visibility and information exchange. The number of nations a business operates in (Georearch) is also statistically significant (p-value = 0.02) and negative, indicating a 4% drop in transparency for every extra nation a business works in. The intricacy of handling information over larger geographic areas may be the cause of this. Blockchain technology usage is significantly positively correlated (p-value < 0.001). Blockchain-using businesses are 35.9% more transparent than non-using businesses, which may have a beneficial effect on information visibility and traceability in the supply chain. Companies in the dataset appear to have a baseline level of transparency (46.4% on average), even in the absence of other factors, according to the positive and marginally significant coefficient of the constant (p-value = 0.064).

However, Company size (p-value = 0.595), supply chain complexity (p-value = 0.54), and company CSR activities (p-value = 0.54) do not significantly influence supply chain transparency. This result is presented in Table 2.

Table 2

Linear Regression

CSSChainTrans	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CPYsize	-.022	.041	-0.53	.595	-.102	.059	
TechAdoption	.564	.088	6.37	0	.389	.739	***
GeoRearch	-.04	.017	-2.35	.02	-.073	-.006	**
CSR	.032	.052	0.61	.54	-.07	.134	
CBlkChainTech	.359	.086	4.17	0	.189	.529	***
Constant	.126	.068	1.87	.064	-.007	.26	*

Mean dependent var	0.464	SD dependent var	0.500
R-squared	0.718	Number of obs	153
F-test	74.748	Prob > F	0.000
Akaike crit. (AIC)	39.782	Bayesian crit. (BIC)	57.965

*** p<.01, ** p<.05, * p<.1

Test of Model Fit

Even more so than the ethical sourcing model, the R-squared value (0.718) shows that the model explains 71.8% of the variation in supply chain transparency. This implies that this model has a higher capacity for explanation. The model as a whole appears to be statistically significant and has some degree of confidence in its ability to predict transparency, as indicated by the statistically significant F-test (p-value < 0.000). This result is presented in Table 2. Overall, the findings imply that operating in fewer geographic areas and using blockchain technology are significant indicators of increased supply chain transparency in Ghana's cocoa industries. Subsequent studies might examine the precise processes via which blockchain promotes transparency and look at how blockchain interacts with other elements like geographic reach.

4.1.3 Factors Influencing Transparency Agricultural Sector Supply Chain Transparency in Ghana

Blockchain adoption in the agriculture industry shows a positive and statistically significant link with supply chain transparency (p-value < 0.001), meaning that adopting firms have 85.3% more transparency than non-adopting ones. This is the greatest correlation found in all three models, demonstrating the significant influence of blockchain technology on agricultural transparency. The technology adoption variable (TechAdoption) is positively correlated and marginally significant (p-value = 0.058), indicating that businesses that are usually receptive to using new technologies may also be more transparent by 8.6%. It nevertheless maintains the relationship between higher visibility and technological adoption but is weaker than the blockchain effect. A company's size (p-value = 0.471), the number of areas it works in (p-value = 0.369), the number of suppliers it uses (p-value = 0.348), and its cooperative social responsibility initiatives (p-value = 0.213) are among the other characteristics that have no impact on the transparency of the agricultural sector. This result is presented in Table 3.

Table 3

Linear Regression

ASSChainTrace	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CPYsize	.018	.025	0.72	.471	-.031	.067	
TechAdoption	.086	.045	1.91	.058	-.003	.176	*
GeoRearch	-.009	.01	-0.90	.369	-.029	.011	
SSChianComplexity	.012	.013	0.94	.348	-.014	.039	
CSR	.038	.03	1.25	.213	-.022	.098	
ABlkChainTech	.853	.045	19.11	0	.765	.941	***
Constant	-.043	.064	-0.68	.499	-.17	.083	

Mean dependent var	0.493	SD dependent var	0.502
R-squared	0.904	Number of obs	152
F-test	228.795	Prob > F	0.000
Akaike crit. (AIC)	-122.322	Bayesian crit. (BIC)	-101.155

*** p<.01, ** p<.05, * p<.1

Test of Model Fit

With an astoundingly high R-squared value of 0.904, the model accounts for a staggering 90.4% of the variance in the transparency of the agriculture sector. This points to a powerful model with outstanding explanatory capacity. The model as a whole is statistically significant and has high confidence in its ability to predict transparency, according to the statistically significant F-test (p-value < 0.000). To determine for sure if blockchain directly produces transparency or whether other variables interact, more study may be required. This result is presented in Table 3.

The analysis is predicated on a particular context and dataset. Overall, the findings unequivocally show that blockchain technology adoption has a large and statistically significant positive influence on Ghana's agriculture sector supply chain transparency. This result is consistent with the previous models and highlights how blockchain technology might improve ethical sourcing and transparency.

4.1.4 Factors Influencing Supply Chain Transparency in the Agricultural Sector in Ghana

Blockchain usage in agriculture is positively correlated with supply chain transparency (p-value < 0.001). This is consistent with the other models, highlighting the significant advantages of blockchain for transparency. Additionally, there is a marginal significance (p-value = 0.002) of the 21.4% increase in transparency among organizations that are typically receptive to embracing new technology. This supports the idea that increased exposure and technological adoption go hand in hand. There is a marginally significant trend toward more openness among larger organizations (p-value = 0.059). Although the effect size is reduced, scale and resources may still be beneficial.

Transparency is not substantially impacted, nonetheless, by a company's supply chain complexity (p-value = 0.338), geographic reach (p-value = 0.959), or CSR initiatives (p-value = 0.214). This suggests that spatial complexity may not be as important in agriculture as it is in the cocoa industry model. This result is presented in Table 4.

Table 4

Linear Regression

ASSChainTrans	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CPYsize	.069	.036	1.90	.059	-.003	.141	*
TechAdoption	.214	.066	3.23	.002	.083	.345	***
GeoRearch	.001	.015	0.05	.959	-.028	.03	
SSChianComplexity	.019	.019	0.96	.338	-.02	.057	
CSR	.056	.044	1.25	.214	-.032	.143	
ABlkChainTech	.596	.065	9.12	0	.467	.725	***
Constant	-.175	.094	-1.86	.065	-.36	.011	*

Mean dependent var	0.454	SD dependent var	0.500
R-squared	0.793	Number of obs	152
F-test	92.754	Prob > F	0.000
Akaike crit. (AIC)	-6.286	Bayesian crit. (BIC)	14.881

*** p<.01, ** p<.05, * p<.1

Test for Model fit

With a very high R-squared value of 0.793, the model explains a considerable 79.3% of the variance in the transparency of the agriculture sector. This points to a strong model with strong explanatory capabilities. The model as a whole is statistically significant and has high confidence in its ability to predict transparency, according to the statistically significant F-test (p-value < 0.000). This result is presented in Table 4. Overall, the findings are consistent with the previous models and provide solid evidence for the beneficial effects of blockchain technology adoption on Ghana's agriculture sector transparency. This demonstrates how blockchain technology can revolutionize ethical sourcing methods and supply chain transparency in several industries.

4.2 Discussions

Drawing from the theoretical foundations of the Diffusion of Innovation Theory as well as the body of existing literature on blockchain technology in Ghana's agricultural and cocoa industries, the research investigates the impact of blockchain technology on ethical sourcing and supply chain transparency. As per Rogers (2003), the theoretical framework posits that the adoption of blockchain technology follows a predictable pattern that starts with the dissemination of the invention and progresses through phases of persuasion, decision-making, implementation, and confirmation. This research examines the use of blockchain technology and its impact on the transparency and ethical sourcing methods of the cocoa and agriculture sectors. Prior research has examined the potential benefits of blockchain technology for supply chain transparency and traceability, particularly in Ghana's cocoa and agriculture sectors. Studies by Adu-Gyamfi and Boateng (2019), Musah et al. (2020), and Quayson (2021) have shown how blockchain may help farmers, improve fair trade procedures, and reduce fraud. However, rather than offering empirical proof through real-world application, the bulk of previously conducted research has focused on theoretical frameworks and conceptual discussions.

The current study carried out an empirical analysis of how blockchain technology influences ethical sourcing and transparency in Ghana's cocoa and agriculture industries to address this imbalance. The procedure comprises compiling data from 153 blockchain-using companies across many industries. Key variables such as supply chain transparency, ethical sourcing, corporate social responsibility, technology adoption, and blockchain usage are examined using regression analysis.

The study's conclusions provide significant new insights into the factors influencing ethical and transparent sourcing in Ghana's cocoa and agriculture sectors. Regression analysis shows that companies using blockchain technology are more likely to pursue ethical sourcing and that the adoption of blockchain technology is a major factor in predicting ethical sourcing practices in the cocoa sector. Similarly, blockchain adoption and supply chain openness in the agriculture and cocoa sectors are positively connected. These results lend credence to the theoretical underpinnings of the Diffusion of Innovation Theory, which argues that the adoption of new technologies may enhance the accountability and transparency of supply chains. Blockchain technology has the potential to address concerns of justice, accountability, and trust in agricultural supply chains, as evidenced by the statistically substantial positive correlation between its adoption and ethical sourcing practices. Through an immutable and visible record of transactions, blockchain reduces the risk of fraud, exploitation, and unethical behavior by enabling stakeholders to authenticate the origin and route of products. This finding is consistent with past research by Adu-Gyamfi and Boateng (2019), who demonstrated how blockchain technology may help fair trade laws and ensure that farmers are fairly compensated.

Additionally, the association between supply chain openness and the usage of blockchain technology suggests that the traceability solutions offered by blockchain technology contribute to increased accountability and transparency throughout the whole supply chain. Companies that employ blockchain technology are more adept at monitoring production processes, tracking the movement of goods, and informing stakeholders of important information. This is in line with a study conducted in 2020 by Musah et al. that demonstrated how blockchain technology might improve information sharing and reduce fraud in agri-food supply chains.

Blockchain technology strongly predicts ethical sourcing and transparency, whereas other attributes like business size, geographic reach, and supply chain complexity do not statistically significantly correlate with these results. This implies that the implementation of blockchain technology may have a bigger influence on fostering ethical sourcing practices and supply chain transparency than traditional organizational characteristics and operational difficulties. Nevertheless, it's crucial to consider the potential and industry-specific, context-specific challenges when implementing blockchain solutions.

The overall findings of the study demonstrate how blockchain technology has the power to completely transform agricultural supply chains in terms of transparency and ethical sourcing. The study provides concrete

evidence of the advantages of blockchain adoption, which contributes to the growing body of research on technological innovation and sustainable supply chain management. More research should be done to better understand the mechanisms behind the relationship between supply chain performance and blockchain technology. They might also investigate the repeatability and scalability of blockchain-based agriculture solutions in different settings. The study's conclusions add to our understanding of how blockchain technology may enhance ethical sourcing and transparency in Ghana's agriculture and cocoa sectors. This study provides important insights for practitioners, scholars, and policymakers who aspire to use blockchain technology for sustainable supply chain management through the empirical validation of the theoretical framework of the Diffusion of Innovation Theory.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

This study has provided significant insight into how blockchain technology might enhance ethical sourcing and supply chain transparency in Ghana's agriculture and cocoa sectors. Based on the theoretical framework of the Diffusion of Innovation Theory, the study examined the adoption process of blockchain technology and its implications on supply chain operations using empirical data collected from 153 enterprises operating in diverse industries.

The study's findings demonstrate a strong beneficial relationship between blockchain usage, ethical sourcing practices, and supply chain transparency. Companies that employ blockchain technology are considerably more likely to use ethical sourcing methods and exhibit higher levels of transparency than those that do not. These results highlight the potential of blockchain technology to address issues of justice, accountability, and trust in agricultural supply chains. They are also in line with recent research highlighting the importance of blockchain technology in promoting fair trade practices and reducing fraud.

Our understanding of the factors influencing supply chain outcomes in the cocoa and agricultural sectors is improved by this study. Transparency and ethical sourcing seem to be significantly influenced by blockchain, but conventional organizational characteristics like size and operational complexity are not as important. This demonstrates that the revolutionary potential of blockchain technology may have a bigger influence on sustainable supply chain practices than traditional factors.

The findings of the study will impact researchers, practitioners, and policymakers in many ways in the future. These data might be used by legislators to develop incentives and regulations that encourage the application of blockchain technology in agricultural supply chains, increasing transparency and accountability. Blockchain technology can help companies and farmers alike enhance their ethical sourcing practices and gain a competitive edge in the market. By exploring the mechanisms behind the relationship between supply chain outcomes and blockchain technology, researchers may build on this work. They may also look at how well blockchain technologies scale and replicate in different agricultural settings.

All things considered, by highlighting how blockchain technology can completely transform agricultural supply networks in Ghana and beyond, this study contributes to the growing body of research on technological innovation and sustainable supply chain management. This study provides empirical evidence of the advantages of blockchain adoption, which opens the way for further advancements in ethical sourcing, sustainable agriculture, and supply chain transparency.

5.2 Recommendations

Ghana's cocoa and agriculture sectors have immense potential, but they face challenges such as unethical sourcing and a lack of transparency that hinder their growth. Blockchain technology emerges as a game changer, offering a secure and verifiable way to track products from farm to shelf. This essay explores how embracing blockchain can revolutionize these industries, promoting ethical practices and ensuring a more sustainable future.

Widespread adoption is crucial for the success of blockchain. Companies, industry associations, and government agencies must join forces to drive this change. Initiatives such as training programs, awareness campaigns, and financial incentives can make blockchain adoption more accessible. However, smaller businesses require additional support. Technical assistance, educational programs, and fostering connections between farmers and technology providers are key to bridging the digital divide and empowering them to participate.

Collaboration is at the heart of an effective blockchain system. When all stakeholders, from farmers to retailers, participate in this shared network, it strengthens traceability and transparency across the entire supply chain. This not only ensures ethical sourcing but also empowers consumers to make informed choices about the products

they buy. However, infrastructure limitations, particularly in rural areas, pose a significant challenge. Limited internet access, unreliable electricity, and a lack of digital literacy can hinder farmers' ability to utilize blockchain effectively. Investing in infrastructure development is crucial to bridge this gap and empower rural communities to actively participate in the digital transformation.

Regulatory frameworks play a vital role in ensuring the ethical use of blockchain. Governments must develop laws that address data privacy, establish regulations for digital transactions using smart contracts, and promote compatibility between different blockchain systems. This fosters trust and creates a secure environment for all participants.

Educating consumers is another critical piece of the puzzle. As demand for ethically sourced and sustainable products rises, empowering consumers with knowledge about how blockchain verifies product origins and promotes responsible practices is essential. This awareness can incentivize companies to invest in blockchain-based traceability systems, creating a market advantage for those committed to ethical sourcing.

Finally, continued research and development are vital to unlock the full potential of blockchain. Funding research projects that explore new applications in agricultural supply chains, assess the social and economic impacts of adoption, and develop scalable solutions tailored to the needs of local stakeholders is crucial for ensuring long-term success.

By embracing these recommendations, Ghana can unlock the transformative potential of blockchain technology. From promoting ethical sourcing to fostering transparent supply chains, blockchain paves the way for a more sustainable and competitive agricultural industry, ultimately benefiting both farmers and consumers.

REFERENCES

Adu-Gyamfi, R., & Boateng, R. (2019). Blockchain technology in Ghana's cocoa sector: Promoting ethical sourcing and supply chain transparency. *Journal of Agricultural Economics and Rural Development, 5*(2), 102-115.

Akoto, E. Y., Boateng, G. O., & Acheampong, A. (2023). Blockchain-based traceability system for cocoa beans in Ghana: A conceptual model and implementation framework. *Journal of Food Engineering, 230*, 111456.

Amegashie-Duvon, E. (2014). *Understanding the perceptions of traceability systems in the cocoa supply chain: a case of Ghana* (Doctoral dissertation, Newcastle University).

Anane, J. K., Debrah, Y. A., & Owusu, G. (2022). Exploring the potential of blockchain technology to ensure fair labor practices in the Ghana cocoa supply chain. *Journal of African Business, 23*(2), 397-418.

Bai, C., Quayson, M., & Sarkis, J. (2022). Analysis of Blockchain's enablers for improving sustainable supply chain transparency in Africa cocoa industry. *Journal of Cleaner Production*, *358*, 131896.

Chandan, A., John, M., & Potdar, V. (2023). Achieving UN SDGs in Food Supply Chain Using Blockchain Technology. *Sustainability*, *15*(3), 2109.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. *Trends in food science & technology*, *91*, 640-652.

Kraft, S. K., & Kellner, F. (2022). Can Blockchain Be a Basis to Ensure Transparency in an Agricultural Supply Chain? *Sustainability*, *14*(13), 8044.

Mathew, B. T. (2020). *Attributes of Commodity Supply Chains: Feasibility of Blockchain Technology for Responsible Sourcing* (Master's thesis, University of Waterloo).

Mensah, A., Adjei, S., & Osei-Bonsu, J. (2020). Blockchain technology and supply chain transparency in Ghana's agricultural sector: A theoretical perspective. *International Journal of Business and Economic Sciences Applied Research, 13*(2), 76-88.

Musah, I., Owusu, A. N., & Adjei-Mantey, D. (2020). Analysis of blockchain's enablers for improving sustainable supply chain transparency in Africa cocoa industry. *Research in Policy and Society, 4*(2), 192-201.

Musah, S., Medeni, T. D., & Soylu, D. (2019, October). *Assessment of the role of innovative technology through blockchain technology in Ghana's cocoa beans food supply chains*. In 2019 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) (pp. 1-12). IEEE.

Owusu-Ansah, W., & Asamoah, A. (2018). Exploring the potential of blockchain technology for enhancing transparency in Ghana's agricultural supply chain. *Journal of Development Perspectives, 14*(1), 59-72.

Quayson, B. (2021). Blockchain as a tool for empowering cocoa farmers in Ghana. *African Journal of Business & Management (AJBM)*, 12(2), 162-175.

Rogers, E. M. (2003). *Diffusion of innovations* (5th Ed.). Free Press.

Salih, S., & Mhlanga, D. (2023). Blockchain for Food Supply Chain: Trust, Traceability, and Transparency Enhancement, How Can Africa Benefit?. *The Fourth Industrial Revolution in Africa: Exploring the Development Implications of Smart Technologies in Africa*, 311-325.