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Blockchain Technology Application and Supply Chain Collaboration of Energy Companies in Rivers State of Nigeria

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Abstract: *This study examined the impact of block chain technology application on supply chain collaboration of energy companies in Rivers State of Nigeria. The population of the study consisted of 295 registered energy companies operating in Rivers State of Nigeria. To obtain the sample size, the Krejcei and Morgan's formula was used to determine a sample size of 169 Energy companies. The simple random sampling technique was used to obtain two (2) executives from each of the 169 companies under study, to turn up 338 management staff for the whole sample. A 4-point likert-scale structured questionnaire was distributed to the respondents, of which out of the 338 copies of structured questionnaire distributed, 246 copies accounting for 73% were retrieved from the respondents, and after data cleaning, 202 (82%) of the questionnaire were found useful for analysis, The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance. The findings revealed that, BTC-enabled visibility strongly, positively and significantly influencesupply chain collaboration. It was also, found that BTC-enabled traceability moderately, positively and significantly influencesupply chain collaboration. The study therefore, concludes that blockchain technology application positively and significantly influences supply chain collaboration of energy companies in Rivers State and recommends that,Energy companies have to prioritize blockchain activities such as BTC-enabled visibility and BTC-enabled traceability to manage and strengthen their supply chain collaboration activities and improve their performance.*

Key words: *Blockchian technology application, BTC-enabled traceability, BTC-enabled visibility, supply chain collabioration*

INTRODUCTION

A growing number of products are delivered to the customers by means of supply chains that consist of independent firms (Christopher & Peck, 2012; Wang., Jie &Abareshi, 2018). Manifold supply chain partners have to work as one collaboratively to put together and distribute products and services to the consumer. Porter (2019) noted that supply chain management concept essentially transforms the nature of a company as control has ceased to anchor on straight direction of the internal business procedures, but somewhat anchored on integration crosswise affiliate organizations in the supply chain. Supply chains constitute a nucleus area for companies and carries out four indispensable functions: sales, distribution, production, and procurement (Arshinder,Kanda & Deshmukh, 2008). Companies encounter amplified uncertainty, confrontations, and constrictions, owing to globalization, elevated customer expectation, market competition, supply chain complexity and uncertainty, these constraints straightforwardly influence companies performance and frequently result in challenges and constrictions, such as soaring operation costs or capacity deficiency, which possibly will be determined by the Blockchain rising (Tapscott & Tapscott, 2016).This calls for harmonization and collaboration crosswise the supply chains and the necessity for information technology (Huddiniah & Er, 2019) This implies that, a crisis in this area can hamper good organization and postponements in the delivery of goods to consumers and a loss of revenue. Companies have therefore, automated their processes, and by this means have contributed to a boost in the quantity of digitized data equally emanating from inside the organization and from outside the organization by means of distributors, freight and transportation sources such as Blockchain, which is a distributed data configuration that is simulated and shared in the midst of the affiliates of a network (Greenspan, 2015).

The block chain technology which was launched with Bitcoin, as a trendy form of digital crypto currency developed by Satoshi Nakamoto in 2008, is a central distributed sheltered technology in the existing Industry 4.0 epoch in recent times and has fascinated immense interest from both academia and industry (Dobrovnik, Herold, Fürst & Kummer,2018; Swan, 2017). Blockchain is identified as distributed ledger technology (Tschorsch&Scheuermann, 2016), which allows partakers to secure the settlement of business deals, document the business deal, and transmit assets economically (Tschorsch & Scheuermann, 2016).Block chain technology is an innovative brand of internet infrastructure anchored on distributed applications as well an innovative brand of supply chain network, which possibly will offer a new prototype for future business (Hackius & Petersen, 2017; Mansfield-Devine, 2017; Swan, 2015).

Sourcing of raw materials, product manufacturing and delivery of products to end consumers have led to data surfacing and becoming an aspect of daily human activity. This lift up in data has presented opportunity for novel advances and techniques to generate, store, analyze and get hold of constructive imminence from the supply chain. The emergence of blockchain technology has therefore conveyed innovative possibilities extended from financial services to supply chain management, intelligent manufacturing and Internet of things. The materialization of the Internet of things signifies a boost in connectivity and information sharing and hence a need for increasing trust and efficiency in dealings which may affect the supply chain and its resilience to pull through from all categories of disruptions (Mondragon, Mondragon & Coronado, 2018).

The tracking of all categories of business deals more visibly and firmly by means of Blockchain technology motivates an investigation on the opportunities Blockchain technology tenders crosswise the supply chain. However, there have been very few studies conducted on the nexus between block chain technology application and supply chain collaboration (Bai & Sarkis, 2020; Chang & Chen, 2020; Vos, 2018; Petersson & Baur, 2018). Therefore, this paper tries to fill this research gap by investigating the impact of Block chain technology application (BTC) using BTC-enabled visibility and BTC-enabled traceability as dimensions on supply chain collaboration of energy companies in Rivers State.

Research Objectives

The main objective of this study is to ascertain the influence of blockchain technology application on supply chain collaboration of energy companies in Rivers State. The specific objectives are:

$_1$: To examine the influence of BTC-enabled visibility on supply chain collaboration of energy companies in Rivers State.

$_2$: To examine the influence of BTC-enabled traceability on supply chain collaboration of energy companies in Rivers State.

$_3$: To identify and highlight key attributes of blockchain technology applicable to supply chain collaboration of energy companies in Rivers State?

Research Questions

RQ1: To what extent does Btc-enabled visibility of blockchain technology influence supply chain collaboration of oil and gas companies in Rivers State.?

RQ2: To what extent does BTC-enabled traceability of blockchain technology influence supply chain collaboration of oil and gas companies

RQ3: What are the key attributes of blockchain technology applicable to supply chain

collaboration of energy companies in Rivers State?

LITERATURE REVIEW AND HYPOTHESES

Technological Determinism

This study is anchored on technological determinism. Technological determinism was derived from Thorstein Veblen (1987-1929), and centered on the affiliationamid technology and society. Technological modernism modifies how society functions. Simply put, technological determinism stem from the conviction that technology is the principalenergy in a society (Smith & Marx, 1994). Technological determinism is the foundation for influencing society and any vitaloccurrence in society is as a result of a quantity of innovation. The theory is envisaged on the principle that

technology more than any other significantdynamic play and does settle on social change (Bimber, 1990). The whole society's life and several facet of human communication have systematically changed owing to the spreading out of computers, networks and the internet (Hauer, 2017). This theory is relevant to this present study because recent blockchain technological progression has affirmed itself in the way human produce, dispense and appraise knowledge, skills and information in the present day. The hall mark of the above declaration epitomizes the standard used to communicate as influencer of the intellect of the receiver.

Block Chain Technology Application

The technology underlying Bitcoin is named Blockchain which acts as the payments layer for Internet (Sultan & Lakhani, 2018). Blockchain is a decentralized database enclosing chronological, cryptographically connected blocks of digitally indicated asset deals, presided over by a consensus model (Sultan & Lakhani, 2018). It is a mechanism for bringing up to date exactness of states in distributed computer networks (Swan, 2016). Blockchain, also branded as the consensus protocol, doles out as a public or private ledger for any transactions, enabling every user to hook up to the network and send transactions to the Blockchain, confirm transactions and generate new Blocks (Herlihy & Moir, 2016). Blockchain, in short, is a record-keeping system that stores information about transaction records shared peer-to-peer crosswise all computers contained by its network, and allows diverse organizations to collaborate and validate entries in the Blockchain hence giving stakeholders visibility of the overall activities taking place.

Key Attributes of Blockchain

In this subsection, based on previous studies we identified the key attributes of the blockchain technology. Blockchain technologies have the following key attributes: Jawaji *et al*. (2020) point out that Blockchain implements transparency, security, authenticity, and auditability. Yang *et al.* (2019) assert that the attributes of blockchain consist of decentralization, security, visibility and Zheng*et al.* (2018) affirm that the key distinctiveness of a blockchain embrace decentralization, persistency, anonymity, and auditability. Sultan and Lakhani (2018) emphasize four nucleus attributes of blockchain: immutable, decentralized, consensus driven, and transparent. Chen *et al*. (2018) categorize four features: decentralization, traceability, immutability, and currency properties. This study, based on the above, investigates decentralization, immutability: Transparency, Security, Authenticity, Traceability and Visibility as the key attributes of blockchain applicable to supply chain collaboration in Energy Companies in Rivers State.

There are many factors, which would influence the blockchain applications in supply chain collaboration; however, each industry may have dissimilar focal points or main concerns. As a result, it is wise to evocatively evaluate the use of blockchain in terms of the definite necessities in a meticulous business area spotlighted on three significant realistic insinuations: information sharing, traceability and automation within digital transformation (Chang & Chen, 2020; Frank, Dalenogare& Ayala, 2019; Wollschlaeger, Sauter & Jasperneite, 2017). Since blockchain, which is a trusted, auditable and decentralized system can be employed to handle personal data (Zyskind, Nathan & Pentland, 2015), these three globally accepted situations express the application of blockchain in supply chain collaboration. This present study investigates two attributes of blockchain technology (visibility and traceability), renamed them as BTC-enabled visibility and BTC-enabled traceability and adopts them as the dimensions of blockchain technology application.

BTC-Enabled Visibility

Visibility guarantees self-assurance into the supply chain and puts offoverreactions, pointless involvements and unproductive decisions in a risk event state of affairs (Soni, Jain & Kumar, 2014). Information sharing is the ability of the firm in sharing knowledge with supply chain partners in an effective and efficient approach. The unavailability or absence of the information essential to decision making can damage the competence of a company (Ouabouch & Paché 2014). In supply chain processes, bulky number of communications and documentations necessitate plenty of exertions and time to pull through. These embrace legal documents and contracts which companies will sustain costs to make available and convey. Blockchain could present an answer, as every document or paper can be uploaded and shared to departments or business, thus appreciably dropping the endeavors for communications or transporting papers and improving the information sharing in a supply chain (Benton *et al.,* 2018; Wollschlaeger *et al.,* 2017).

BTC-Enabled Traceability

BTC-enabledtraceability can be used to offer identification and trace the raw materials and final products in supply chains. In a supply chain arrangement, partners can employ this attribute of blockchain to trace and keep an eye on blocks in the network. The block may enclose vital information, products, process history, shipments, components, etc. Traceability facilitates information sharing, which advances the visibility and transparency of supply chains, making it easier for partners to speedily access information exclusive of permissions (Apte & Petrovsky, 2016; Hackius & Petersen, 2017; Swan, 2017). BTC-enabledtraceability can also be applied to numerous functions of a Supply Chain Management (SCM) schemes, such as logistics, quality assurance, inventory management (Ju, Jongwook & TaehoParkc, 2019). Owing to the blueprint of blockchain, each and every one user can without difficulty trace the block in the network, because transactions or records are stocked up correspondingly in dissimilar blocks and connected by the cryptographic hash function, making available a significant trait to trace the blocks.

Supply Chain Collaboration

Supply chain collaboration is well thought-out as a significant factor to realize a win-win resolution for diverse shareholders in a supply chain (Ramanathan & Gunasekaran, 2014; Tsou, 2013). Besides, Soosay and Hyland (2015) stress that collaboration includes long-standing commitments to technology sharing and to directly incorporate planning and control systems. Different forms of supply chain collaborations exist, including collaborative planning, collaborative decision making and collaborative execution (Ramanathan & Gunasekaran, 2014). Supply chain collaboration involves a high level of commitment, trust, joint decisions and information sharing (Liao *et al*., 2017; Pradabwong *et al.,*2017; Soosay & Hyland, 2015; Zhang & Cao, 2018). A high level of supply chain collaboration show the way to advanced levels of supply chain performance (Chen *et al*., 2017; Wiengarten *et al*., 2016). Supply chain collaboration is thus, a firm's capability to sense, work in partnership, synchronize and reconfigure the elements in a supply chain as well as internal cross-functional integration and external integration with suppliers and customers.

Empirical Review

Chen *et al*. (2020) considered a block chain-driven platform for supply chain finance and to establish a reliable and efficient financing platform for the auto retail industry in China. The

findings of the study show that, participants in supply chain (SC) networks in block chain built-in trust mechanism, work broadly and visibly to run a dependable, well-situated, and distinguishable business; similarly, the traditional supply chain finance (SCF), partial automation of SCF workflows in the midst of less human errors and interruptions was realized through smart contract in BCautoSCF. Such open and secure features suggest the feasibility of BCautoSCF in SCF.

Dinesh, Manoj and Anandh (2020) investigated blockchain technology in food supply chain security in India using the methods of information science, management science, system science and other theories and empirical research methods, chiefly by means of the PEST analysis, compare and exhibit studying the appliance of Blockchain in the food supply chain. It was established that, transactions are cryptographically secured by means of double SHA 256; Bit algorithm guarantee immutability, transparency, distributed and easy to uphold; blockchain transaction secured cryptographically by means of Hashing algorithm Double SHA 256; the blockchain can keep the information secured void of manipulation. The blockchain technologies realize multifaceted enterprise of the food supply is the government demand, through the system of food market transaction record.

Vos (2018) presented a blockchain-based decentralized system for freight declaration and aims to make simpler and automate the collaboration among the economic operators and the Customs agencies. By digitizing the shipment containers through the Internet of Things (IoT) technology, this system intends to improve the responsiveness of the Customs Authority concerning the shipped goods and their shipping conduit. These two systems target the international trading state of affairs, with contributors situated both within and outside the country. It revealed that the applicability of such solutions is limited, since the keenness of the contributors to link with the network is a major concern.

Petersson and Baur (2018) explored how blockchain technology could be put into practice in supply chains and focused on the predictable benefits on collaboration and add to the appreciation of the upcoming potentials of the technology. By means of a qualitative multiple case studies with eight firms operating in varied business fields as different as pharmaceutical, automobile and shipping industry, six semi-structured interviews were performed in cooperation with firms proffering blockchain solutions and firms involved in the technology. Extra secondary data from two firms including supporting material via the involvement at a blockchain seminar and webinar were composed. Mainly, secondary data emanating from whitepapers, company presentations and information from the websites were engaged to attain triangulation of the empirical data, and it was demonstrated that, the application of blockchain technology positively influences supply chain collaboration.

Based on the review of literature, the following research model was developed:

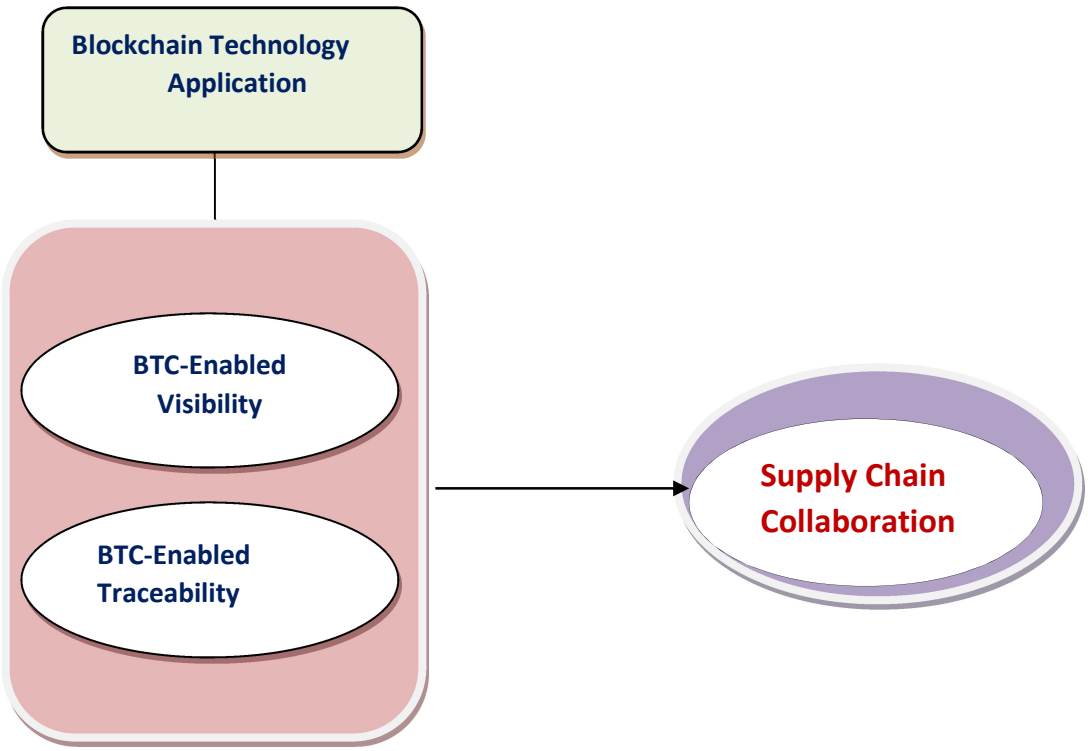

Figure 1: Conceptual Framework of Block Chain Technology Application and Supply Chain Collaboration.

Source: Designed by the Researcher, 2022.

Based on the conceptual framework of block chain technology application and supply chain collaboration, the following hypotheses were formulated:

Ho_1: There is no significant influence of BTC-enabled visibility on supply chain collaboration of oil and gas companies in Rivers State.

Ho_2: There is no significant influence of BTC-enabled traceability on supply chain collaboration of oil and gas companies in Rivers State.

METHODOLOGY

The population of the study consisted of 295 registered energy companies operating in Rivers State of Nigeria as at October, 2020 when the survey was conducted. To obtain the sample size, the Krejcei and Morgan (1970) formula was used to determine a sample size of 169 Energy companies. The simple random sampling technique was used to obtain two (2) executives from each of the 169 companies under study, to turn up 338 management staff for the whole sample. A 4-point likert-scale questionnaire was distributed to respondents, of which out of the 338 copies distributed, 246 copies accounting for 73% were retrieved from the respondents, and after data cleaning, 202

(82%) of the questionnaire were found useful for analysis, The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance. The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance.

RESULTS

Data and Reliability Indices

Prior to and after the survey had been completed, the reliability scales was further examined by computing their co-efficient alpha by means of Cronbach alpha to measure the reliability of the instruments used for the study.

Table 1: Reliability measure of Blockchain Technology Application and Supply Chain Collaboration

S/N	ITEM	NUMBER OF ITEMS	INDEX
1.	BTC-Enabled Visibility	3	0.817
2.	BTC-Enabled Traceability	3	0.846
3.	Supply Chain Collaboration	3	0.864

Source: Field survey data, 2022).

Table 1 summarizes the reliability result of the block chain technology (BTC-enabled visibility and BTC-enabled traceability) and supply chain collaboration). All items were found to be reliable and are used to study the impact of block chain technology on supply chain collaboration of energy companies in Rivers State of Nigeria.

Answers to Research Questions

RQ1: To what extent does BTC-enabled visibility influence supply chain collaboration of energy companies in Rivers State.?

Table 2: Mean and standard deviation of BCT-Enabled Visibility and Supply Chain Collaboration (n=202)

S/N	ITEMS	VLE	LE	HE	VHE	(x)	STD	Remark
1.	Using BTC-enabled visibility to simplify supply chain collaboration	9 (4.50)	7 (3.50)	74 (36.6)	112 (55.4)	3.14	.85	High Extent
2	Using BTC-enabled visibility that can positively affect the strategies used in the production/process of your company and her supply chain performance.	6 (3.0)	7 (3.5)	16 (7.9)	116 (57.4)	3.41	0.85	High Extent
3.	Using BTC-enabled visibility that can positively guarantee self-assurance into your company's supply chain and puts off unproductive decisions.	8 (4.00)	7 (3.50)	35 (17.3)	152 (75.2)	2.14	0.99	Low Extent

Source: *SPSS Window Output on Research Data, 2022.*

Table 2 shows that all the items were rated within 214 – 341, indicating that the respondents agreed to a high extent with the first and second items, but a low extent on the third item. Thus, the sampled companies used BTC-enabled visibility to simplify supply chain collaboration and positively affect the strategies used in the production/process of their company and her supply chain performance to a high extent, but use BTC-enabled visibility to positively guarantee self-assurance into their company's supply chain and puts off unproductive decisions to a low extent.

RQ2: To what extent does BTC-enabled traceability influence supply chain collaboration of energy companies in Rivers State?

Table 3: Mean **and standard deviation of BTC-Enabled Traceability and Supply Chain Collaboration (n=202)**

S/N	ITEMS	VHE	HE	LE	VLE	$(\bar{x})$	STD	Remark
1.	Using BTC-enabled traceability to offer identification and trace the raw materials and final products in supply chains.	10 (10)	5 (2.50)	109 (76.3)	78 (38.61)	3.10	0.86	High Extent
2.	Embarking on BTC-enabled traceability that would lead to efficient distribution of products.	- -	- -	75 (37.1)	127 (62.9)	2.15	0.99	Low Extent
3.	Embarking on BTC-enabled traceability to increase supply chain collaboration.	9 (4.50)	16 (7.90)	129 (63.9)	48 (23.0)	3.18	0.92	High Extent

Source: ***Source:*** *SPSS Window Output on Research Data, 2022.*

Table 3 demonstrate that all the items were rated within 2.15 – 3.18, indicating that the respondents agreed to a high extent with the first and third items, while the second item was rated low extent. Thus, the sampled companies use BTC-enabled traceability to offer identification, trace the raw materials and final products in supply chains and increase supply chain collaboration to a high extent. However, the sampled companies use BTC-enabled traceability to attain efficient distribution of products to a low extent.

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RQ3: What are the key attributes of blockchain technology applicable to supply chain

Collaboration of energy companies in Rivers State?

In research question three, the researcher sought to ascertain the key attributes of blockchain technology applicable to supply chain collaboration of energy companies in Rivers State. The descriptive relationships between the attributes of blockchain technology applicable to supply chain collaboration were ascertained through the analysis the graphical representation of respondents' inputs as presented in Table 4.

Table 4: Blockchain Technology Attributes applicable to Supply Chain Collaboration (n=200)

SN	Blockchain Technology Attributes	Frequency	Percentage
1	Decentralization	29	14
2	Immutability	31	15
3	Authenticity	16	8
4	Transparency	70	35
5	Visibility	12	6
6	Traceability	44	22
	Total	**202**	**100.00**

Source: SPSS Window Output, Version 22.0 (based on 2022 field survey data).

The participants in this study identified six categories of blockchain attributes that are applicable to supply chain collaboration in energy companies in Rivers State. Table 4 reveals that the six attributes of blockchain and the respondents there includes 29 for Decentralization (14%), 31 for Immutability (15%), 16 for Authenticity (8%), 70 for Transparency (35%), 12 for Visibility (6) and 44 for Traceability (22%). This is further illustrated in Figure 2.

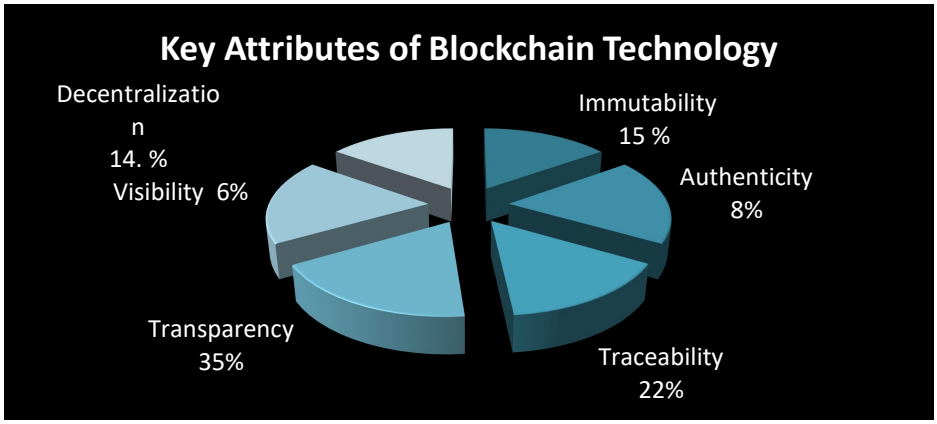

Figure 2: Graphical Presentation of Key Attributes of BlockchainTechnologyapplicable to Supply Chain Collaboration of Energy Companies in Rivers State**.**

As can be seen from Figure 2, the option on the use of Transparency attribute had more respondents, followed by Traceability attribute. The attribute of Immutability produced the third highest response on the instrument, responses on attribute of Decentralization recorded fourth position, and the attribute of Authenticity attribute had the fifth position while, the least response rate came from the attribute of Visibility. Thus, the responses were composed of disparate options of block chain key attributes for supply chain collaboration.

Test of Hypotheses

Influence of BTC-Enabled Visibility on Supply Chain Collaboration

Table5: Influence of BTC-Enabled Visibility on Supply Chain Collaboration (n=202).

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.692	.481	.429	2.872

a. Predictors: (Constant) BTC-Enabled Visibility

b. Criterion: Supply Chain Collaboration

Source: SPSS Window Output, Version 22.0, 2022.

Table 5 shows the model summary, depicting how much of the variance in the dependent variable (supply chain collaboration) is explained by the independent variable (BTC-Enabled Visibility). The model portrays that with the R (Coefficient of Correlation) that there is 69.2% direct relationship between BTC-enabled visibility and supply chain collaboration, and R–Square value of .481, depicting that BTC-Enabled Visibility accounts for 48.1% of variances in supply chain collaboration. The remaining 51.9% is due to other variables that will affect supply chain collaboration but are not present in the model.

Table 6: ANOVA of the influence of BTC-Enabled Visibility on Supply Chain Collaboration (n=202).

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3201393	1	3201393	648433	.0000
Within Groups	1481137	201	199595		
Total	4682530	202			

a. criterion: Supply Chain Collaboration

b. Predictor: BTC-Enabled Visibility

Source: SPSS Window Output, Version 22.0, 2022.

Table 6 shows that between BTC-enabled visibility and supply chain collaboration, F(dfB,dfw)=F(334,1) =648433, p<0.05. Significant value is 0.01,r (1,334). The results of the findings above revealed that the level of significance was 0.00 which is less than 0.05. This implies that the null hypothesis is rejected and the regression model is significant in predicting the effect of BTC-Enabled Visibility on Supply Chain Collaboration.

Influence of BTC-Enabled Traceability on Supply Chain Collaboration

Table 7: Influence of BTC-Enabled Traceability on Supply Chain Collaboration (N=202).

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.442	.195	.191	3.576

a. Predictors: (Constant), BTC-Enabled Traceability

b. Criterion Variable: Supply Chain Collaboration

Source: SPSS Window Output, Version 22.0 (2022).

Table 7 shows the model summary, depicting how much of the variance in the dependent variable (supply chain collaboration) is explained by the independent variable (BTC-Enabled Traceability). The model portrays that with the R (Coefficient of Correlation) that there is 44.2% direct relationship between BTC-enabled traceability and supply chain collaboration, and R–square value of .195, depicting that BTC-enabled Traceability accounts for 19.5% of variances in supply chain collaboration. The remaining 80.5 % is due to other variables that will affect supply chain collaboration but are not present in the model

Table 8: ANOVA of the influence of BTC-Enabled Traceability and Supply Chain Collaboration *(N=202).*

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	77.074	1	77.074	374.879	.0000
Within Groups	23.849	201	206		
Total	100.94	202			

a. Criterion variable: Supply chain collaboration

b. Predictor: BTC-Enabled Traceability

Source: SPSS Window Output, Version 22.0 (2022).

Table 8 shows that between block chain technological application and BTC-enabled traceability F (dfB,dfw) =F(334,1) =77.074, p<0.05. The results of the findings above revealed that the level of significance was 0.00 which is less than 0.05. This implies that the null hypothesis is rejected and the regression model is significant in predicting the effect of BTC-enabled traceability on supply chain collaboration.

DISCUSSIONS OF FINDIINGS

The aim of this study was to investigate the connection between blockchain technology application and supply chain collaboration within energy companies in Rivers State. To achieve this aim, the study considered the influence on supply chain collaboration by two blockchain competitive attributes, namely BTC-enabled visibility and BTC-enabled traceability. The association between each set of constructs is discussed in terms of the results of the null hypothesis. The first null hypothesis (Ho_1) was rejected since BTC-enabled visibility had a considerable and statistically significant impact (r=.692; p=.0000) on supply chain collaboration. By inference, within energy firms, an increase in BTC-enabled visibilitysimplifiessupply chain collaboration, positively affect the strategies used in the production/process of companies and her supply chain performance,and positively guarantee self-assurance into company's supply chain and puts off unproductive decisions to attain a physically powerful impact on supply chain collaboration. Likewise, the existence of BTC-enabled visibility in an energy company necessarily point to the entrenchment of more vigorous blockchain activities within the supply chain by that energy company. Our empirical findings showed that higher visibility lead to a higher level of supply chain collaboration. The current study corresponds to earlier results such as: Joon-Seok and Nina (2019) that blockchain technology characteristics (information transparency, information immutability, and smart contracts) have significant positive effects on partnership growth and marginal effects on partnership efficiency, and Chen (2020) whose findings show that, participants in supply chain (SC) networks in blockchain built-in trust mechanism, work broadly and visibly to run a dependable, well-situated, and distinguishable business.

The second null hypothesis (Ho_2) was rejected since there was a moderate positive and statistically significant association (r=.442; p=.0000) between BTC-enabled traceability and supply chain collaboration. This result demonstrates that supply chain collaboration is likely to improve as BTC-

enabled traceability increases within energy companies supply chains. Equally, it is commonsense to presume that energy companies that have established BTC-enabled traceability with their partners also exercise consequential supply chain collaboration. In other words, BTC-enabled traceability amongst energy companies predicts supply chain collaboration. Consistent with these results, a number of studies (Peterson & Baur, 2018; Vos, 2018; Dinesh *et al*., 2020) concluded that, the application of blockchain technology positively influences supply chain collaboration.

CONCLUSION ANDRECOMMENDATION

This study investigated the impact of blockchain application on supply chain collaboration. The application of blockchain to supply chain collaboration of energy companies in Rivers State is functional because of blockchain attributes such as decentralization, immutability: Transparency, Security, Authenticity, Traceability and Visibility are applicable to supply chain collaboration in Energy Companies in Rivers State. With respect to this study, two attributes of blockchain application, namely BTC-enabled visibility and BTC-enabled traceability, were adopted as the dimensions of blockchain application. For supply chain collaboration, BCT-enabled visibility and BCT-enabled traceability attributes revealed positive effects. Interestingly, in the context of this study, the greatest impact on supply chain collaboration in energy companies in Rivers State originates from BTC-enabled visibility. The study therefore, concludes that, blockchain technology application significantly influences supply chain collaboration of energy companies in Rivers State,and recommends that, to remain competitive, Energy companies have to prioritize blockchain activities such asBTC-enabled visibility and BTC-enabled traceability to manage and strengthen their supply chain collaboration activities and improve their performance.

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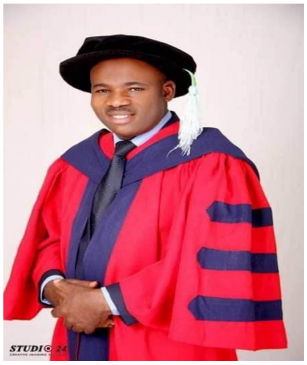

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