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SECURED DATA FRAMEWORK FOR SHIPPING IN NIGERIA, USING BLOCKCHAIN TECHNOLOGY

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Abstract

Port operations account for over 80% of trade and logistics life cycle globally. And in Nigeria, it is estimated to account for about 95% of trade, and contribute 2.1% to the country GDP. The challenges of the Nigeria Maritime sector is well documented. As posited in this dissertation, it includes manual documentations, duplication of operational processes, lack of a central electronic network portal, limitation of the electronic bill of lading, and lack of transparency in operations. This dissertation adopted the Hyperledger Fabric permissioned network to provide a consensus electronic platform for stakeholders. The existing electronic bill of lading is incorporated and traded as transaction asset on the Blockchain, and stakeholders as the nodes on the network. Three of the Regulatory Agencies acts as validators of transactions and are responsible for the update of the Blockchain. The nodes have at least two peers, for initiating and endorsing transactions. In addressing the operational challenges in the shipping sector in Nigeria, this project provides a framework of streamline processes, for the entire trade cycle. A chaincode (smart contract) of BOL transacted on the Fabric network, and an electronic portal, that function as a Port Community System. Other shipping documents such as custom declarations, packing list, Certificates of Origin and others can be implemented via a chaincode, on the fabric Blockchain. There is, however, a need to domesticate multilateral and plurilateral agreements as regards international trade, especially the MLTER model (law on electronic transferable records).

1.0   Introduction.

Port operation and shipping transportation are important aspect of international trade. It is reported that more than 80% of world trade transaction is globally freighted via sea, with two third of it happening in developing

countries ports (United Nations, 2018).In Nigeria case, the volume of trade is about 95%, and its importance to the nation economy, with an estimated $8 billion component of the country oil and gas industry, cannot be overemphasized (Opportunities, 2019). This makes every effort at improving port operations desirous and imperative for collaborative efforts, as well as trade agreements on international standards with local legal backing to achieve.

The partial privatization of the ports in Nigeria is the most successful and biggest reform initiative of the Nigeria government till date. An Estimated investment of over $6 Billion in fees and infrastructure development was anticipated (Kruk, 2008). However, this has not translated to efficient, transparent and operational reliable shipping experience for all stakeholders.

With emerging technologies, application of Permissioned Blockchain Technology is expected to be of tremendous benefit to the port industry.

The World Bank forum white paper refers to Blockchain as part of the 4th Industrial revolution, needed to eliminate trade barriers and help in streamlining trading process. It made reference to the successful trial by IBM and Maersk, on a test shipment of flowers from Kenya to Port of Rotterdam, Netherlands, and disclosed that over 200 stacks of documents were involved in that transaction!(Paper, 2018). The eliminations of such documents and processes not only increases efficiency, it equally reduces fraudulent practices around the supply trade. It went on to postulate that Blockchain will boost global trade by about $1.1 trillion in the next decade.

2.0 Background to the Study

The Nigeria Port presently consist of the Nigeria Port Authority (NPA) as the landlord, and thirteen (13) Private terminal operators (TORs) handling daily operational activities. Each port consists of a custom command, with Nigeria Custom Service (NCS) statutory required to collect cargo duties, tax and revenue on behalf of the government. Other agencies and stakeholders play different roles in the trade cycle within the Nigerian maritime domain.

The dependencies on manual processes in the ports operations makes adequate planning and tracking of shipments difficult. It often results in delays, high risk assessment, errors, litigations, demurrage, false declarations, port congestion and so on.

The Lagos Chamber of Commerce and Industry (LCCI), illustrated that Nigeria Maritime economy was losing roughly 727, 660 Million naira in customs revenue, about 3.638 billion naira for non-oil export and over 2, 183-billion-naira corporate revenue annually. Also, the ports perform poorly on ease of doing business rating, as measured by the World Bank forum (an indicator for measuring the effectiveness of Ports) where Nigeria was rated 182/183 out of 185 countries in its 2015-2017 report (LCCI, 2018).

Several efforts to resolve these challenges, including adopting technology like the adoption of electronic bill of lading, Nigeria Custom trade facilitation portal and other initiatives, have not provided the desired effects.

Several benefits of Blockchain Technology have been highlighted, ranging from cost reduction, to simplification of documentation, improvement of transparency, trade facilitation among others(Stokel-Walker, 2017). The cost of an extra day delay to a shipping line, with a 2,200 TEU is estimated to be about $35,000 (Olaogbebikan et al., 2014).

Blockchain technology is novel and adoption is yet low in Nigeria, especially in the shipping Industry. However, there have been impactful reviews and implementation of Blockchain Technology globally.

One of such is the implementation of *TradeLens,* by collaboration of the shipping company, Maersk and IBM, a technology firm.The Application was built using Hyperledger Fabric framework. The need for proper implementation and collaboration was highlighted when the project was initially rejected by major competitors to Maersk in the shipping and logistic business (Andersen & Vogdrup-Schmidt, 2018).

And the Blockchain Bill of Lading (BBOL) fulfills the legal requirements of the UNCITRAL Model Law on Electronic Transferable Records (MLETR) and the Rotterdam Rules. The token model of electronic bill as obtained in BBOL, gives the following comfort:

- On the spot verification just like paper documentation

- Holders of the token can be verified easily hence interest protected.

- Remedies for breach of contracts can be claimed.

This dissertation therefore provides the implementation and adoption framework of the Permissioned Blockchain Technology in Nigeria shipping sector to address its peculiarport operation challenges among others such as inconsistent government policies, inefficiency, improper documentations by Port users and under-declaration by importers (Ports, 2014).

Aim and Objectives

This dissertation reviews the shipping ecosystem in Nigeria, and adopted the Hyperledger Blockchain Technology, with specific objectives to:

1. Identify and automate one of the most important shipping documents in the Nigeria shipping Industry, applying the Blockchain Technology. This is the Blockchain Bill of Lading (BBOL).

2. Design a permissioned, peer-to-peer distributed network platform within the ecosystem to cater for documentexchanges and provide platform for trade facilitation.

3. Identify similar processes that can be align and design smart contracts for such transactions.

4.0 **Methodology Overview**

The step by stepprocess involves:

i. Identification of the Actors: - These are the various stakeholders within the Nigeria shipping Industry. Everyone is expected to pre-register on the network. This endear a level of trust and hence dictate the consensus algorithm adopted. The actors includeshipping companies, the terminal operators, the custom agents, the regulatory agencies, the banks, the security forces, Federal

Ministries (Finance, Transport, Trade and Industry), some Alma- gated associations, chambers of commerce, IT firms, Logistic firms and so on.

ii. Consensus protocol: A byzantine fault tolerant (BFT) consensus protocol is adopted. This is native to the Fabric Hyperledger Blockchain.It is adopted for cost effectiveness. This allow the adoption of any cryptocurrency, hence allow participant to incorporate their existing or choice of payment gateway.

iii. Membership Service Provider: Aside handling validations of transactions, the three (3) nominated regulatory agencies handles the configuration and endorsement policies, errors and exceptions, registrations of members, revocation of memberships, cryptographic and security tools, update of the Blockchain ledger. This is so, since the Hyperledger Fabric is a distributed system.

iv. Ordering Services: Hyperledger Fabric is installed on every node on the network, with each node having minimum of two (2) peers. One of the peers provides the ordering service, consensus order of transactions and broadcast patterns of blocks among the peers. The other peer(s) initiates transactions peculiar to the organization.

v. Programming Languages: While any of Go, JavaScript (node.js) and Java will do, the Proof-of-concept (PoC) application for this dissertation was implemented with combination of JavaScript for building the network and Java for building the API's business logic for identified transactions.

vi. Smart Contract (Chaincode): An example of a typical business logic here involves transacting a BOL from a customagent, through the Blockchain, to provide a provisional bill. This bill includes the custom duties, the terminal charge, agent fees and other fees, as determine by the type of cargo.

The metadata of identification of all participants is stored within the Chaincode. It manages the state of the assets (electronic transfer or exchange) during transactions.

vii. Ledger: This is the records of values of the transactions. It equally records changes in the states, with timestamping of time of such change. It is connected to the existing database of the stakeholders through API's

viii. Communication layer: We have separate channels for communication between terminal operators and the regulatory agencies, as well as with the custom agents. This ensure confidentiality and reliability of data and trade secrets. There is also a peer-to-peer message transport between the participants' nodes in the network. A gossip protocol is employed to broadcast messages within the network.

A combination of exploratory and numerical method of analysis was carried out. This involved collection and analysis of electronic manifest of past transactions, as primary data and gaining deep insights, through interviews, review of websites of operators and observations of operations in two Nigerian Ports, namely Lagos Port complex and Tin can Port. Furthermore, analysis of Custom HS code, a database of indicative list of charges for different cargo type, was reviewed and use for test case on the Blockchain developed for this project.

The architecture of the network is as depicted in Figure 1, showing all stakeholders, communication channels, as well as the validators of transactions.
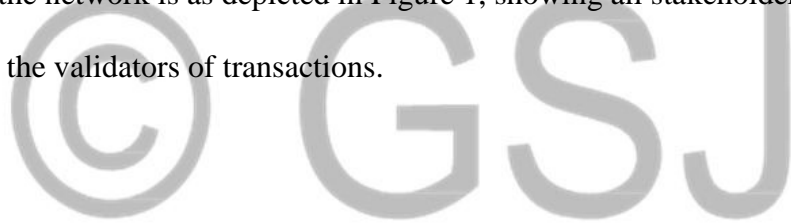
IMPLEMENTATION

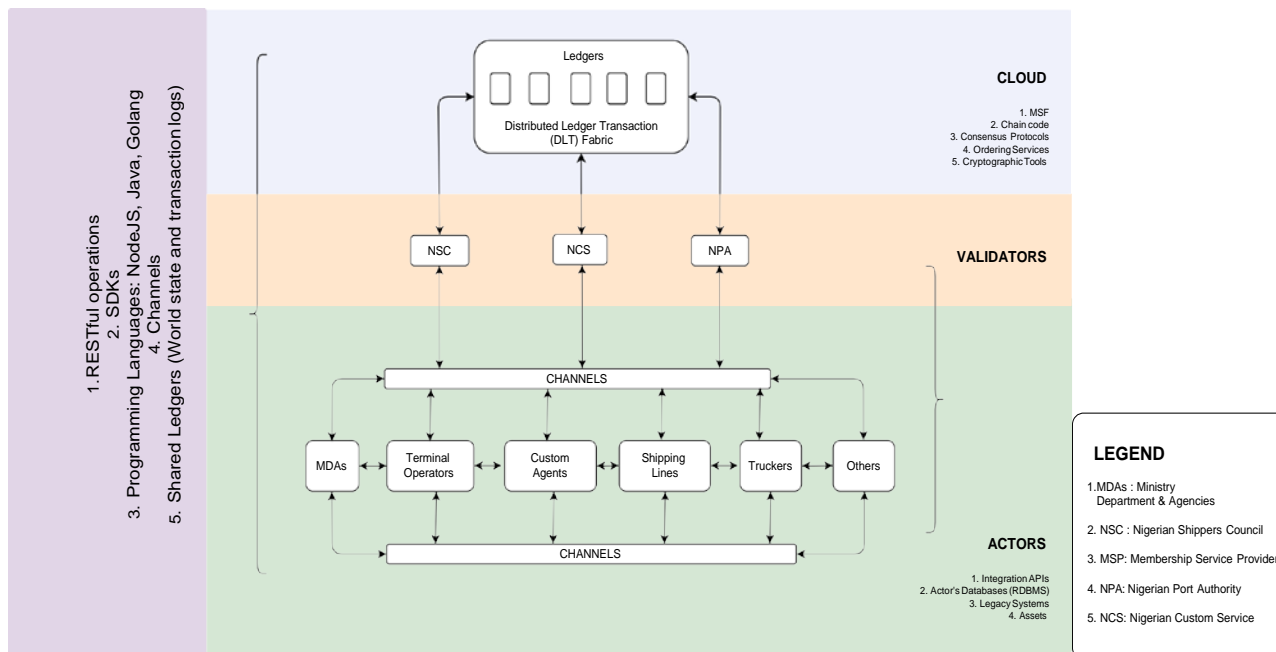ARCHITECTURE

(EXECUTE -ORDER- VALIDATE)

Figure 1: Implementation Architecture, source (Authors, 2020)
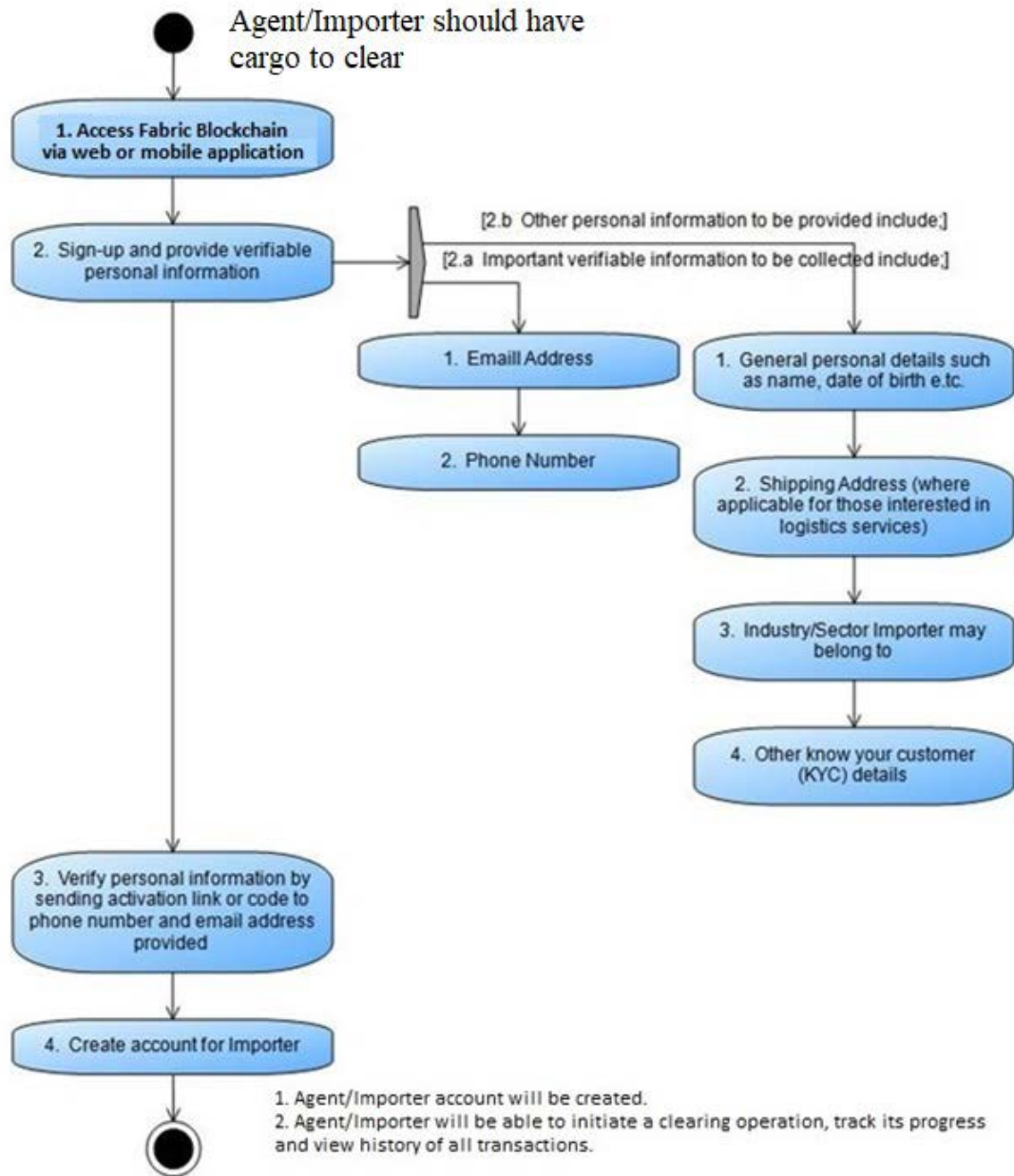
1.1   Use CaseDescription

UC-CIT-1 – Custom Agent Registration

Use Case ID:	UC-CIT-1	Use Case Name:	CA Registration
Description:	This is the process of creating an account for the Custom Agent to have access to the Fabric Network for their clearing process		
Preconditions:	1. Agent/Importer should have cargo to Clear		
Postconditions:	1. Importer/Agent account will becreated 2. Agent will be able to initiate a clearing operation, track its progress and view history of alltransactions as part of the network stakeholder 3. Have Manifest/BOL for upload		
Normal Flow:	1. Access Fabric Blockchain Network via the web or mobileapplication 2. Sign-up and provide verifiable personal information, verified by the MSP 3. Verify personal information by sending activation link or codeto phone number and email addressprovided 4. Create account forCustom Agent		

Alternative Flows:	2.a Important verifiable information to be collectedinclude;
	    1. EmaillAddress
	    2. PhoneNumber
	2.b Other personal information to be providedinclude;
	    1. General personal details such as name, date of birthe.tc.
	    2. Shipping Address (where applicable for those interested in logisticsservices)
	    3. Industry/SectorAgentmay belongto
	    4. Other know your customer(KYC) details

Related Requirements		
REQ-CIT-1	Customer Registration	Functional

UC-CIT-1 – Custom Agent Registration

UC-CIT-2 - Agency Account

Use Case ID:	**UC-CIT-2**	Use Case Name:	**Agency Account**
Description:	The Fabric Network MSP provides channel access to the regulatory agencies to manage staff access, peer nodes, Custom Agents, Customers etc on the network. It view previous transactions, initiate new transactions, track progress of active transactions, make enquiry and give feedback.		
Preconditions:	1. Agency with business to the Ports 2. Have clear transaction interactions with other stakeholders		
Postconditions:	1. A set of agencies as validators of transactions 2. Smart contracts for transactions		
Normal Flow:	1. Gain access to personalprofile 2. Navigate to initiate a newtransaction 3. Navigate to track activetransactions 4. Navigate to view previoustransactions 5. Endorse transactions and forward same to the Network. 6. Provide feedback and ratings on the service delivery		

Alternative Flows:	2.a A new transaction canbe
	    1. Cargo clearing via seafreight
	    2. Cargo clearing via airfreight
	    3. Logistics to move cargo from a location toanother
	3.a Tracking active transactionsfor
	    1. Estimated time for clearing activity to becompleted
	    2. Which clearing processes have been completed and which ones are left
	    3. Additional charges whereapplicable
	    4. Feedback provided byagenciesthat have donephysical
	    inspection thecargo		

Child Use Cases	
UC-CIT-2.1	New Transaction

Related Requirements		
REQ-CIT-6	Progress Tracking	Functional
REQ-CIT-8	Reports and Dashboards	Functional

UC-CIT-2 Agency Account

(1)
Agency must be
pre-registered via MSF

(2)
i. Gain access to staff account
ii. Peers & Nodes
iii. Status: Validators or Normal

[2. A new transaction can be]

1. Cargo clearing via sea freight

2. Cargo clearing via air freight

3. Logistics to move cargo
from a location to another

ELSE

(3)
i.Initiate a new transaction
ii.Endorse the transaction

IF CORRECT

(4)
Transfer transaction to blockchain

(5)
-Provide feedbacks & reports,
-Payment status,
-Approvals,
-TOR's Accounts, Agents Accounts,
-Other

[3.a Tracking active transactions for]

1.Estimate time for clearing
activity to be completed

2.Which clearing processes
have been completed and
which on are left

3. Application charges where
applicable

4. Feedback provided by
agencies that have done
physical inspection on the
cargo

5.0   Result

The dissertation provided improved framework for the shipping and logistics sector in Nigeria.

A custom agent submits its BOL once on the Blockchain, and it wasimmediately available to NCS, NPA, NSC, NIMASA, Terminal operators and others that needs it. This remove the need for multiple submission of documents, an essential element for implementation of the National single window and Port community systems.

Equally, the deployment of the Fabric Blockchain, eliminates the third party role play by Banks, and significantly improve the clearing system. The need for collection, processing and submission of Form-M, a prerequisite requirements for import and export processes, PAAR confirmation, that requires Banks to play middle man between NCS and Agents, and other of such is eliminated. This is so, because of the cryptographic tool and timestamping that provides the needed comfort to all parties.

The Figure 2 depicts the existing operational processes, while Figure 3 shows the Blockchain framework. These shows clearly processes like duty certificates, custom duty payment, provisional bills and other such payment can be align in a menu. The clearance certificate, the vessel clearance, sailing certificate, gate pass and others of such can be grouped in a menu.

Author Figure 1
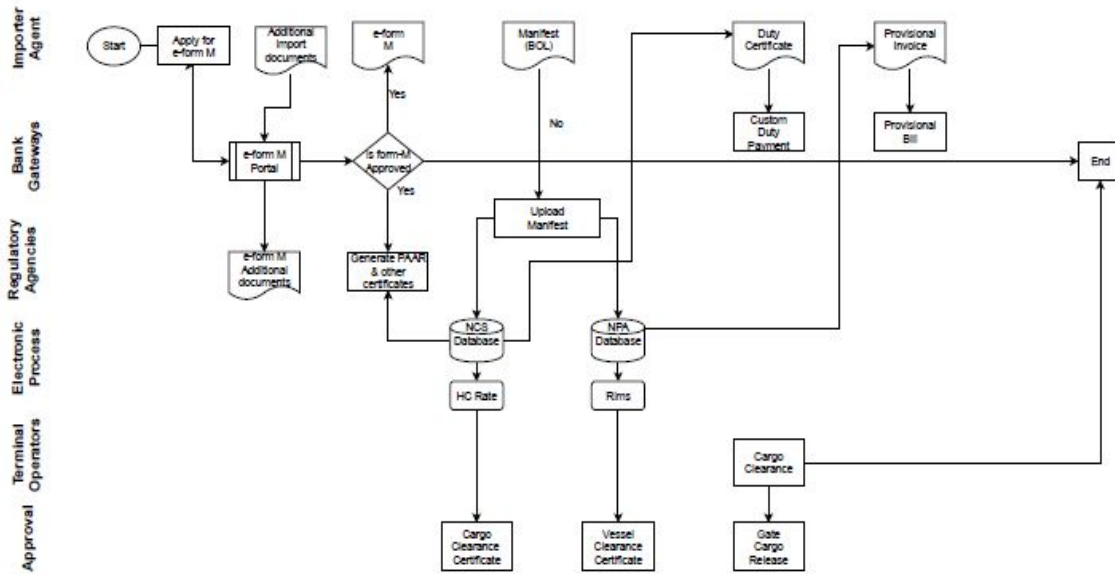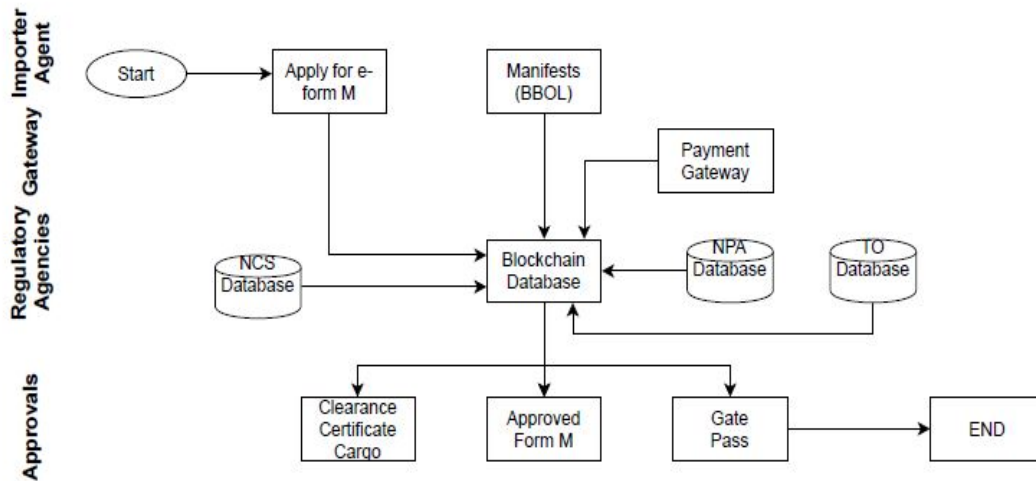
Existing Operational Process

Figure2: Existing Process (Authors, 2020)

Author Figure 2

Proposed Blockchain Framework

Proposed Blockchain Framework

Figure3: Proposed Blockchain Network (Authors, 2020)

6.0   Discussion and Conclusion

Among the various Blockchain frameworks, this dissertation establish the fact that the Hyperledger fabric is most suited for the Nigeria maritime industry. Its modularity, native fabric CA, the consensus and endorsement signature and policies are feature that will allay management and transparency fear.

The table 1 shows the rating of Nigeria Ports. The indices of trading across border clearly shows lots of inefficiency in the shipping business in Nigeria.

From the various reviews and the Blockchain framework of this dissertation, shows clearly the significantly improvements in efficiency, transparency,trust, immutability, interoperability,traceability, reduce cost and wastages, and improve port rating.

Furthermore, the one-to-many relationships of custom agents and shipping lines to regulatory agencies, will be streamlined. This will significantly improve port operations in Nigeria.

Various efforts have been made in time past to improve trade facilitation in Nigeria shipping Industry with little result, by introduction of a single window. The limitation being lack of general acceptance and choice of technology deployed. These limiting factors are addressed by Blockchain implementation. First, there is consensus in managing the network by all stakeholder. And few among the regulatory agencies was made responsible for the correctness of transaction within the network. This gives share responsibility and sense of ownership. The database is distributed in nature, hence each entity maintains its legacy applications, and hence maintain privacy of data.

The dissertation demonstrated the verifiable use of the BBOL as a contract document in the shipping Industry. It therefore suggests that other shipping documents, such as delivery order, packing list, and others can be implemented on the fabric Blockchain network.

The world trade organization (WTO) have opinioned that Blockchain technology can help achieve the global trade facilitation agreement, a process to improve import, export, logistic and maritime process globally. WTO further estimated that a proper implementation of this

technology in developing country, will help reduce cost of transactions and reduce time to import by 47% and time to export by almost 90%. If average time for clearing TEU's reduce to less than 2 days in the first instance, with the implementation of Blockchain, the cost saving and improvement in efficiency gain will be enormous (Ganne, 2018).

7.0   Reference to future works:

The adoption of the UNCTAD MLETR recommendation on electronic documentation for global trade and the localization of such law to the Nigeria context is a major area of exploration that need to be address.

8.0   Contribution to Knowledge:

Many works have been carried out on the challenges of the Nigeria Ports as reviewed here. Equally, the benefits of Distributed ledger Technology and Blockchain Technology in general to global world trade have been well documented.

This dissertation identifies some of the actual processes which when automated with the Blockchain Technology will provided the needed efficiency urgently needed in the Maritime Industry in Nigeria. It equally highlights how the Quay and Land side processes can be streamlined on the Blockchain platform, thereby reducing the cycle time or turnaround time of shipping and clearing process. It certainly will improve the ratings of Nigeria Ports, and established it as the hub of shipping in Africa. It equally provides verifiable implementation of the single window platform most needed for trade in Nigeria.

Table 1

Operational Matrix

S/N	Competitive Metrics	Present Realities	Idea Situation	Source
1	Average Timeline for clearing TEU's	14 days average	48 hours average	From LCCI Report,2017/UNCTAD
2.	Economic Competitive Index	116 (out of 141)		WEF, 2019
3.	Ease of doing Business	146 (out of 190)	Rwanda(29), Kenya(61), Morocco (60)	World Bank, 2019
4.	**Trading across Borders**	**182 (out of 185)**		**World Bank,2018**
5.	No. of paper workflow and regulatory agencies	18 agencies and 23 signatures	Single electronic platform	LCCI reports, 2017
6.	Digitalization	Limited digital economy	Blockchain, IoT, Artificial Intelligence etc.	WEF, 2019

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