PRICE TRACEABILITY AND UNATHORISED STOCKPILE PREVENTION IN SUPPLY CHAIN USING BLOCKCHAIN

BY

Md Azharul Islam Tazib
ID: 153-15-6683
AND

Iftieaq Murshed
ID: 153-15-6572
AND

A. M. Zakir Hossain
ID: 153-15-6694
AND

Shakil Ahammed
ID: 153-15-6580

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering[Font-14]

Supervised By

Dr. Syed Akhter Hossain
Professor & Head
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

AUGUST 2019

APPROVAL

This Project titled **"PRICE TRACEABILITY AND UNATHORISED STOCKPILE PREVENTION IN SUPPLY CHAIN USING BLOCKCHAIN"**, submitted by Md Azharul Islam Tazib, ID No: 153-15-6683, Iftieaq Murshed, ID No: 153-15-6572, A.M. Zakir Hossain, ID No: 153-65-6694 and Shakil Ahammed, ID No: 153-15-6580 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering (BSc) and approved as to its style and contents. The presentation has been held on 14-09-2019.

BOARD OF EXAMINERS

Dr. Syed AkhterHossain — **Chairman**
Professor and Head
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Md. Tarek Habib — **Internal Examiner**
Assistant Professor
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

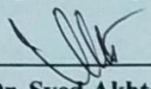
Abdus Sattar — **Internal Examiner**
Assistant Professor
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Dr. Dewan Md. Farid — **External Examiner**
Associate Professor
Department of Computer Science and Engineering
United International University

DECLARATION

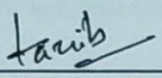
We hereby declare that, this project has been done by us under the supervision of **Dr. Syed Akhter Hossain, Professor and Head, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

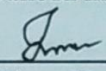


Dr. Syed Akhter Hossain
Professor and Head
Department of CSE
Daffodil International University

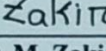
Submitted by:



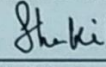
Md. Azharul Islam Tazib
ID: - 153-15-6683
Department of CSE
Daffodil International University



Iftieaq Murshed
ID: -153-15-6572
Department of CSE
Daffodil International University



A.M. Zakir Hossain
ID: - 153-15-6694
Department of CSE
Daffodil International University



Shakil Ahmmed
ID: - 153-15-6580
Department of CSE
Daffodil International University

ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to **Dr. Syed Akhter Hossain, Professor and Head,** Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Blockchain*" to carry out this project. His endless patience ,scholarly guidance ,continual encouragement , constant and energetic supervision, constructive criticism , valuable advice ,reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to Almighty Allah and Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

In recent times, the considerations of improving the product distribution supply structure has been increased worldwide. At the same time, it brings various complexities in the supply chain and things get much adulterated within the supply chain at the time of calamities. For instance, along with the spurious quality in products, prices too get a huge illegal raise and illegal inhuman stockpiling occurs to make the situation even worse. Hence, distribution prices are now to be disclosed and product information is to be shared with consumers.

As it is already mentioned, distribution channels are complicated and supply chain management (SCM) is autonomously attained in an independent manner. For practical reason, it has been repeatedly pointed out that the distribution procedure is not transparent and the distribution margin is pretty high. The propose of this study is to structure a system that pledges the transparency of the product distribution structure by with blockchain and smart contracts in price-tracking segment of supply chain management systems. This approach allows companies as well as any consumers to track their trades, products by enhancing transparency in the Supply Chain Management, thereby blighting down companies and middlemen from having excessive profits. It also enables the authority i.e. Government to prevent stockpiling by monitoring the available stockpile of any product by any organizations or companies at any certain time.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1
Introduction

Introduction

The recent constriction in consumer expense due to global restlessness in distribution prices has raised the importance of improving the product distribution structure. The necessity for a new approach to provide actuality to consumers has increased. Nevertheless, prices in the distributions layer are unstable, and the supply chain structure is often not transparently operated due to the obstructed and complex supply chain management (SCM) operations of companies & middlemen. In early 2000, the Supply Chain Management Framework was first brought up to the light as a new structural business model and a path to strategically manage concern with key customers and suppliers.

In point of fact, many organizations are utilizing the Supply Chain Management Framework to manage their product distribution structure and they are getting benefit out of it. But the fact is, such a complex structural system with many stakeholders and organizations has a complicated distribution structure and a high distribution margin. And there is no single available path for consumers to get information transparently about the margins of the product per distribution channel.

Motivation

Blockchain is standing here for many years now but it got it's boost with Bitcoin application for financial transactions later Ethereum came to field with its versatile apertures of solving many existing problems with blockchain technology. Blockchain establishes transparency at its core and all DAPPS of blockchain is enabling a new dimension of Blockchain.

Blockchain is being utilizing in the field of supply chain such as Food Safety in Supply Chain applications, Quality assuring of products in Supply Chain and on everything's top, financial transactions with a very secured way.

There are many systems exist now that allows traceability and transparency in various complex supply chain but no such study done in the field of traceability and price-tracking in Supply Chain.

In addition, stockpiling in supply chain in different level of stockholders is a common issue in the existing system as no such method is implicated here to identify stockpiling to prevent it. We are intending to do introduce blockchain technology. It will enhance the security of data by decentralizing the database and establishes a transparency in operation processes of different events along with other data.

Rationale of the Study

Establishing traceability in supply chain and ensuring security with Blockchain is a bleeding edge solutions of modern technology. Many researchers in recent times have worked on this problem and proposed many viable solutions for traceability problems in supply chain. As application of Blockchain is about to roll out in a massive quantity in different fields, there are number of researches and developing going on. Lack of transparency in the margin of the product per distribution channels causing instability in markets and unauthorized stockpiling often takes place in the time of calamities to make the situation worsen. Several works have done on quality and safety assurance but no study has done to meet the described problem. Therefore, the problem still exists as to work from the very fundamental. Our study intends to meet this puzzles and to give a structure to a fined solution. Researches is still going on to solve this problem more precisely and more efficiently.

Expected Outcome

This research comprises both a proposition to resolve the stated problems and a naive implementation to experiment the developed hypothesis. The elementary objective of this project is to propose a method that can establish transparency and traceability of margins of profits of the products per distribution channel and to prevent stockpiling by developing smart contracts. The developed structure includes many sub objectives. Among the sub objectives it is expected to solve the following ones:

- Transparency and traceability in supply chain from production to end consumers.
- Ability to detect unauthorized stockpiling.
- Reduces cost for companies in managing supply chain.
- Stability in market.
- Prevent high marginal profits per distribution channel.

CHAPTER 2
Background

Introduction

As mentioned earlier the problem is almost as old as the Products Market System itself. Efficiency and transparency in Supply Chain Management have always been a priority field in research. The more transparent and traceability abled supply chain e can model, the market environment surrounding the products will be more sustainable and responsible. Any governance body can ensure such prevention in unauthorized illegal stockpiling if the SCM system can detect certain stockpiling itself automatically and our study intend to do so efficiently.

Related Works

There have been many researches in the field of Supply Chain Management System to make it efficient and make the participants responsible for the versatile attributes of a product. For the last couple of years, a lot of new approaches and methods have been introduced to meet the problem of transparency and traceability problem in supply chain using Blockchain. Every works has pros & cons. All of the works have been helpful for a better solution later on.

In recent years, combining Blockchain technology with SCM Supply Chain Management has become a new aptitude. Blockchain technology has benefits such as anti-tampering and decentralization and has a flowery future to meet the solutions of the problems of the Supply Chain Management. The recent studies actually work in two directions. First is to give a new sustainable structure of the whole blockchain system from underlying architecture to meet the necessity of the application in supply chain management. And the second one is to ensure the use of the existing blockchain architectures to resolve system security and solve main problems of the SCM (Supply Chain Management)

Shigeru Fujimura, Hiroki Watanabe, 2015 [1] have made a solution of a blockchain-based distributed DAPPS that enables authorization system in order to save data block in the data base that identities in the nodes of SCM (Supply Chain

Management) with the technology of blockchain and give authorization verification feature for the information passing's between different nodes.

Feng Tian, 2016 [2] has developed an agricultural system of supply chain traceability system based on blockchain and Radio-Frequency Identification technology. This developed platform achieved an autonomous collection of information and with Radio-Frequency Identification technology systems and blockchain technology.

Kentaroh Toyoda P. Takis Mathiopoulos, 2017 [3] developed a blockchain Smart Contract system for SCM (Supply Chain Management), using the Ethereum architecture. Item-level Smart Contract to facilitate the information of products in the supply chain was also developed.

IBM assisted with **Tsinghua University** and **Wal-Mart** [4] to establish a food supply chain management system based on IBM own developed HyperLedger blockchain system to facilitate Wal-Mart pork supply chain information.

Daniel Tse, 2017 [5] has studied on the idea of implying blockchain technology to ensure the information truthfulness of food supply chain.

Miguel, 2018 [6] proposed The AgriBlockIoT solution by which integrated Blockchain and IoT. It was implemented by both Hyperledger Sawtooth and Ethereum to understand a food traceability methods. AgriBlockIoT could ensure fault tolerance, data transparency, auditability and immutability.

All of the former studies show us that it is indeed obligated to build such a system that can trace down prices in different channel and to develop a system on blockchain that can detect unauthorized stockpiling in a certain supply chain.

All of the above mentioned works have helped us to find our own way of meeting the solution of the problem.

Research Summery

We have researched the problem and all related works (what could found) to establish a clear understanding of the domain of the problems and to find out what has been

done so far. Some of the other works of other authors have been reproduces in the research partially to get a better result. The investigations show that the problem of Supply Chain Management still exists and it is needed to be addressed and solved.

Challenges

The Supply Chain Management has many interactors and it is a complex system itself. There are many sub problems which are needed to be solved to establish a successful solution.

SCM is very complicated itself. Moreover, the interactors of the Supply Chain are not keen to use such transparent system as it goes against the profitable paths thus making it more challenging to be successful.

Information of product transection are needed to be verified and stored in a manner that will be immutable to any situation and the participants are to be too verified to join the developed Blockchain.

Another problem that is significant is marking down the fraud transections in a versatile manner as a security breech in this section will make the project unsuccessful to be deployed. In addition, a very complex problem is the nature of the data flow in a Supply Chain as there are multiple organizations in a single layers or node participating simultaneously. Computational costs of allocated resources is also a matter of concern as developing a strong consensus mechanism will lead to higher resource cost.

CHAPTER 3
Research Methodology

Introduction

After investigating all existing approaches, we have learned all the convenience of approaches and their abridgements and all available possibilities as well. This chapter of our study contains every steps to our proposed methodology.

Research Subject and Instrumentation

Domain: The targeted problem lives in the domain of Blockchain applications. Though the problems get over multiple domains such as data security, data analytics etc. the comprehensive behavior of the problem is what makes it more identical to its kind.

Instrumentation: To resolve the stated problems of the study it is necessary to use state of the are instruments to meet better result. Our approaches of the desired methodology contain the usage of state of the art instruments as well as algorithms.

Instruments in Blockchain have been improved in a regular basis as it is a Bleeding edge technology and the participants are raising in numbers, the occurrences are also gaining numbers. Some necessary Instrumentations are briefly mentioned here –

1. **Ethereum:** Ethereum is an open source, public, blockchain-based distributed computing platform and operating system featuring smart contract functionality. It supports a modified version of Nakamoto consensus via transaction-based state transitions. There are hundreds of dAPPS developed on Ethereum which have its own token and Ether is a token whose blockchain is generated by the Ethereum platform.
2. **Smart Contracts:** A smart contract is a segment of code of computer protocol intended to autonomously facilitate, check, or ensure the negotiation or performance of a smart contract. Smart contracts enable the acceptance of transactions without any other parties. All recorded transactions are irreversible and trackable.

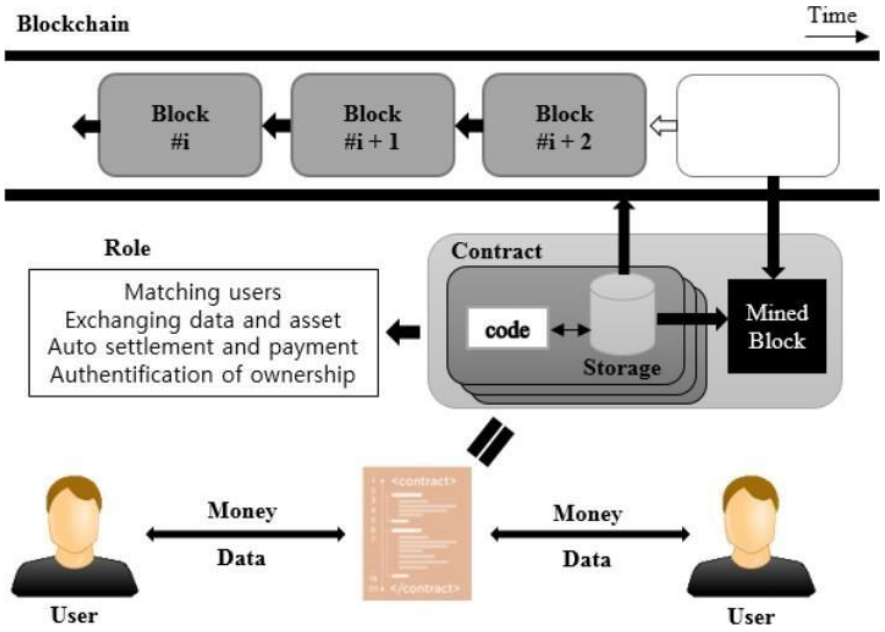


Figure 3.2.2.1: Operations Methods of Smart Contracts.

3. **Consensus Mechanism:** The performance mechanism and security are directly impacted by the consensus mechanism. The **Practical Byzantine Fault Tolerance** (PBFT) algorithm can help by reducing the complexity of exponential to polynomial and generally it consists of three different phases: Pre-Phase, Commit and Reply.

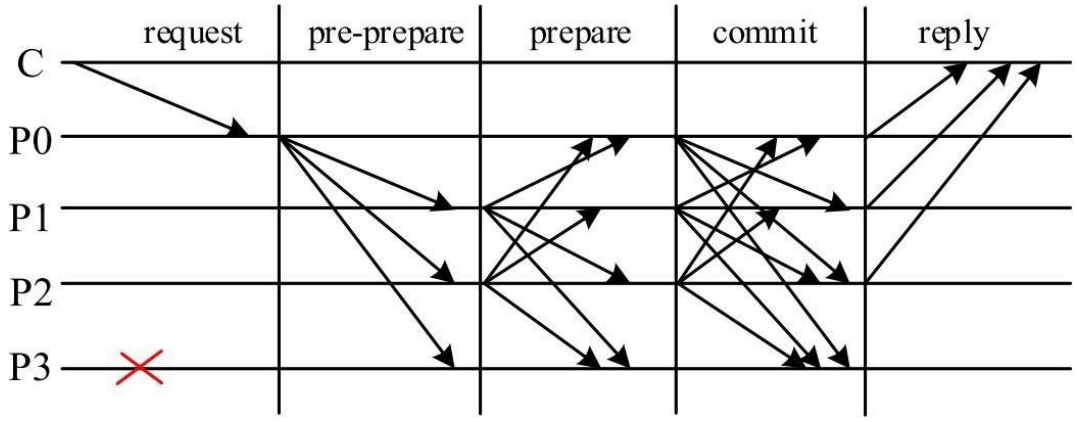


Figure 3.2.3.1: The PBFT Workflow.

As the PBFT in Figure 3.2.1 shows that the C stands for task client and P0-P3 shoes the nodes of the server in the blockchain network. Imagine that there are 3f+1 active servers in the Blockchain network and here we set f = 1. While

circulating the information, say the honest nodes can gain the same information.

Detailed Methodology

This portion contains detailed step by step details of our proposed methodology and works that has been done.

Hierarchical Multi Domain Blockchain Structure:

To meet the current method of SCM structure having lower level local nodes and upper level supervision node, Hierarchical Multi Domain Blockchain Structure based on described PBFT algorithm is proposed in our study.

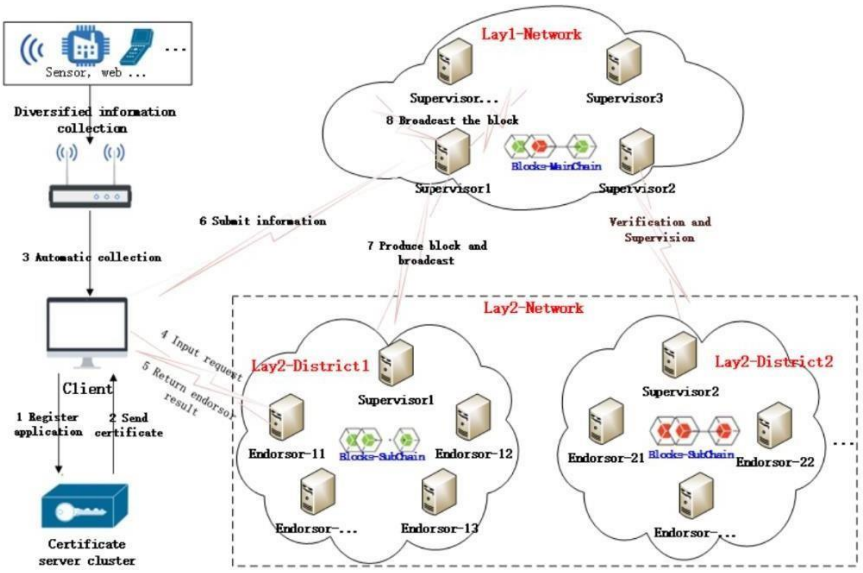


Figure 3.3.1.1: Hierarchical Multi Domain Blockchain Structure

The proposed network architecture shown in figure 3.3.1.1 can support various functions including Certification Authority, Customer Service and can also collect information. Supervision nodes form the upper level HMDBC network and verification of block generation is supported in the level.

Multiple regions form the lower-level network based on different factors (time, region, etc.) and a separate Blockchain network is established in each region.

Two level Verification Mechanism

When a new block is introduced in the system, firstly it is verified by lower level unsupervised nodes in Layer-2 regions of network. Practical Byzantine Fault Tolerance (PBFT) algorithm is followed for running verification of unauthorized node.

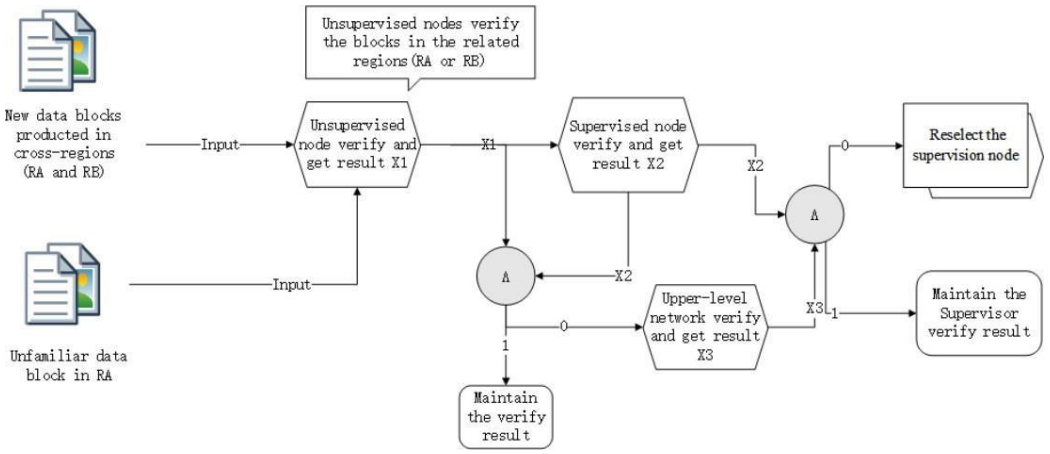


Figure 3.3.2.1: Two level Verification Mechanism

After verification from layer-2, the result is then submitted to the supervisory nodes of the network to run the verification consensus mechanism again to re verify the new block to make an addition as shown in figure 3.3.2.1.

System Structure

In this study we are proposing a smart contract structure for the price tracing system in the Supply Chain Management in figure 3.3.3.1.

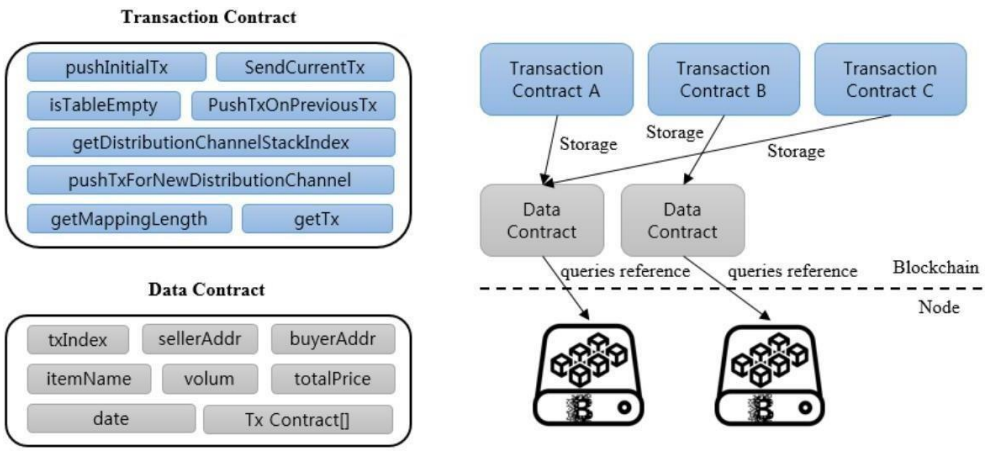


Figure 3.3.3.1: Data references and Smart Contracts on the proposed Blockchain Architecture

Transaction Smart Contract

Transaction smart contracts are contracts that has the collection of function for trading in the supply chain. To store the data of transaction of any occurrences when the channel table is empty, pushInitialTx is used. PushTxOnPreviosTx is used in different manner when the distribution table is not empty. To check if a distribution table is empty or not, isTableEmpty is used. If the table is empty, a new stack is created in the data block and set a unique index. getDistributionChannlStackIndex gets the information of a certain item in SCM.

Data Smart Contract

Data smart contract manages the details of transactions for each item. To identify a transactions txIndex is used. SellerAddres is the account information block of a seller and buyerddr holds the data block of a buyer. itemName indicates to a targeted transaction of a certain product. Tx Contracts[] generates a stack to store the price of the product along the distribution channel and date represents the date of the occurred transaction.

Network Operation

In figure 3.3.4.1, a structure is shown where node is operating during a transaction between buyer and seller.

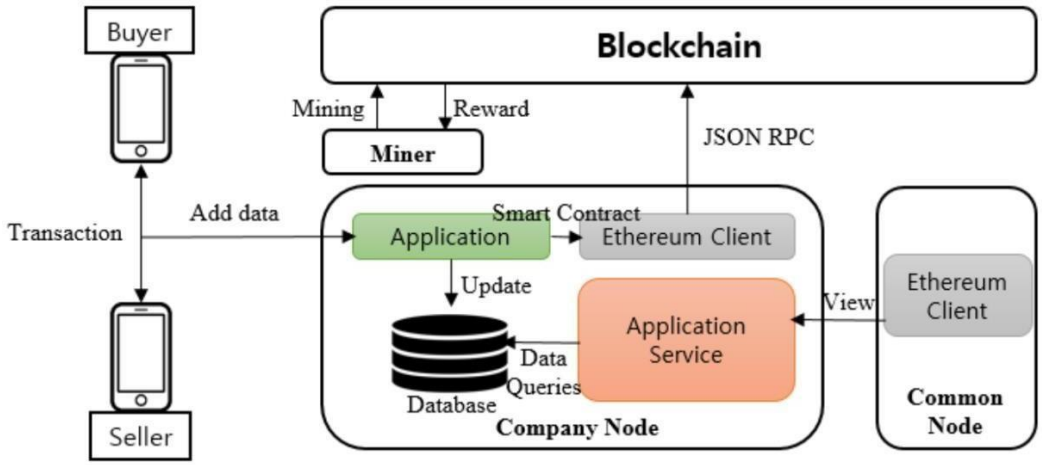


Figure 3.3.4.1: Network Operation

Via cell phone or and web enabled device, sellers and buyers enter information of transaction and when the transaction is transmitted and data block is created, it is transferred to the Layer-1 regional network. Company nodes set at the leyaer-1 supervision region and every node of the system has the copy of the database of the current state of the blockchain. The nodes which are not participating in the supply chain but in the Blockchain are called common node and they are here to facilitate the Ethereum network.

Uploading Data to Blockchain

System of the flow of data block includes the process of uploading data to the blockchain. Figure 3.3.5.1 shows the process of uploading data blocks of the supply chain in the blockchain.

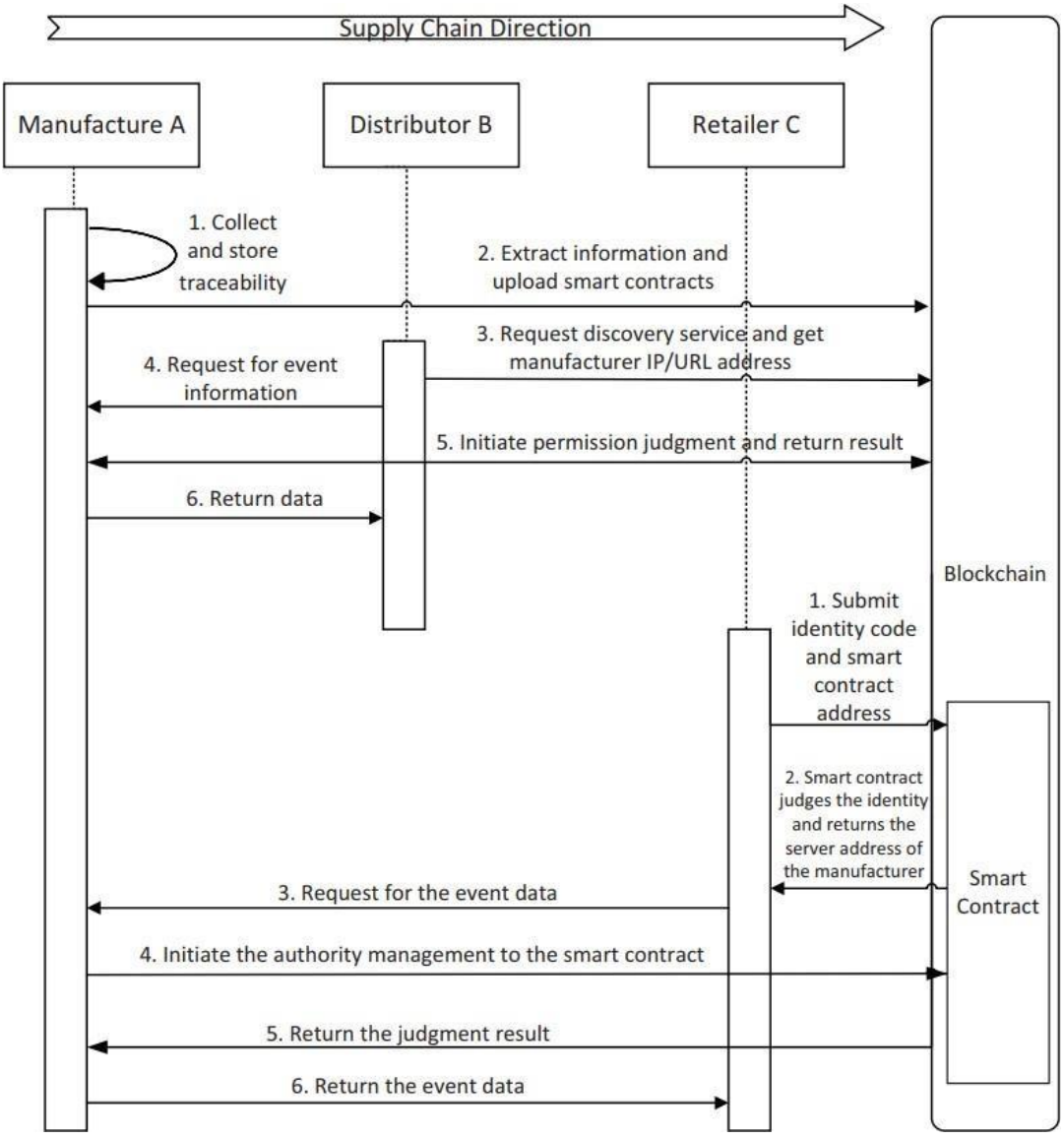


Figure 3.3.5.1: Uploading data block to the blockchain process

Traceability Information Capture Module & Stockpile Detection

To extract information from the proposed system, any interactor can ask for query to fetch data of a certain supply chain. From any given point, i.e. the consumer has to submit the identify code to verify himself and has to address a smart contract described in section 3.3.3. The smart contracts then execute itself and return the traceability information data set to the desired consumer. Every transaction has the field of item volume to record the amount of product sold or bought by any party and from this information the governing body can detect stockpile in the supply chain. As this field is verified by the consensus protocol which will be used for verifying the transaction too, the process is secured.

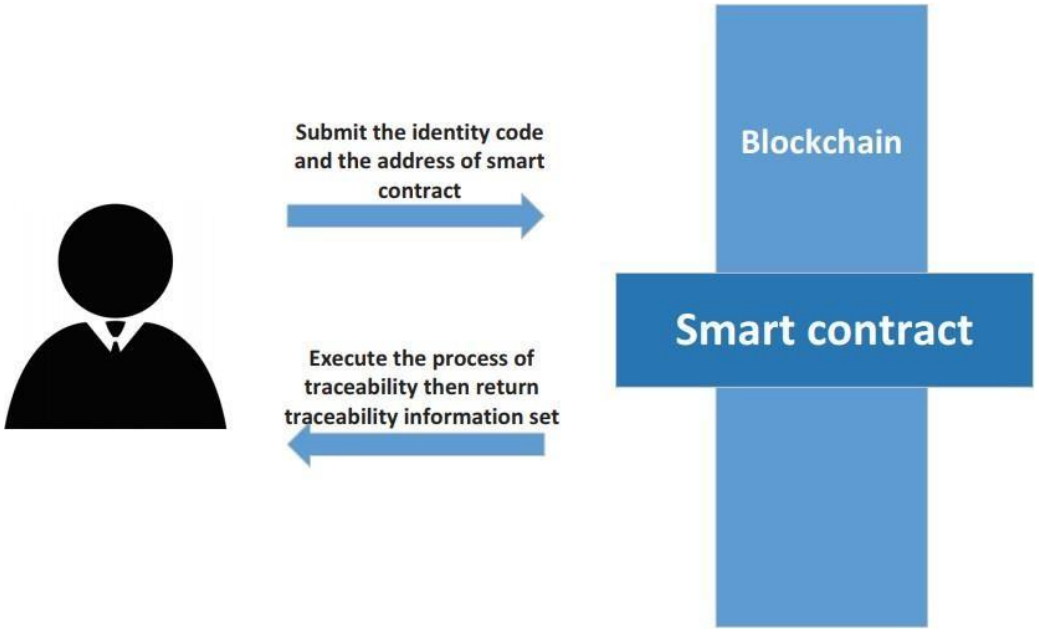


Figure 3.4.1: Processing query of a Consumer

CHAPTER 4
Discussion

4.1 Discussion

In Blockchain based Supply Chain Management system, the tracing of prices of products provides consumers of all level the transparency and reliability of the information. The organizations and companies can monitor the necessity of consumer and consumer can attain the price information prior to having any product that ensure a reverse effect in a goal of stability in price tags of products of market as any high marginal profit in any distributional channel will be identified and can be monitored and action can be taken by the governance body of the market control unit.

In our proposed work we have used Ethereum and to make it sustain, every transaction will cost a fixed percentage of Ether to incentivize the miner of the Ethereum network and to make the network stable. Our study also enlightens the fact of data security as any board of SCM can standardize the point of encrypting the personal information to other layers.

Our proposed HDMBC network price traceability model is based on the PBFT algorithm consensus. Each region can perform and validate the data block when there are less than 33% new data block is available.

CHAPTER 5
Conclusion and Future Work

Conclusion

In our study, we have proposed a traceability system of prices in Supply Chain that can prevent any stockholders of any point of a SCM from perusing in higher margin and it also effect in a positive manner against the pricing of retailer of any consumer products. Along with easy access to the retail price information, it ensures that each transactions in the supply chain is valid and transparent. Any production house can also run a trace back in the process of the raw materials in the distribution channel to flag any mismanagement thus ensuring better quality of a product. Our proposed HMDBC network architecture can supervise the local supervision nodes and can correct the errors and by consensus can also replace any supervision node if it detected to abuse its power.

Future Work

This research work can be extended in many extents to make it more market suitable to close to the current economic structure. Our future goal is to implement in system transection system with in built token of its own kind to make the system more reliable and applicable. The token will have a fixed price against BDT, which will ensure reliability on the system among mass users.

References

[1] Hiroki Watanabe, Shigeru Fujimura, Atsushi Nakadaira, *"BRIGHT: A concept for a decentralized rights management system based on blockchain",* 2015 IEEE 5th International Conference on Consumer Electronics - Berlin (ICCE-Berlin), 2015

[2] Feng Tian, *"An agri-food supply chain traceability system for China based on RFID & blockchain technology"*, 2016 13th International Conference on Service Systems and Service

[3] Toyoda, K., Mathiopoulos, P. T., Sasase, I., & Ohtsuki, T. (2017). *"A novel blockchain-based product ownership management system (POMS) for anti-counterfeits in the post supply chain,"* IEEE Access, 5, 17465- 17477.

[4] Roger Aitken, *"IBM & Walmart Launching Blockchain Food Safety Alliance in China with Fortune 500's JD.com,".* Available: <<https://www.forbes.com/sites/ roge raitken / 2017/12/14/ibm-walmartlaunching blockchain-food-safety-alliance-in-china-with-fortune-500sjd-com/#556eb5fe7d9c>>

[5] Daniel Tse, Bowen Zhang, Yuchen Yang, Chenli Cheng, Haoran Mu. *"Blockchain Application in Food Supply Information Security,"* Proceedings of the 2017 IEEE IEEM, pp.1357-1361, 2017.

[6] Miguel Pincheira Caro, Muhammad Salek Ali, Massimo Vecchio, Raffaele Giaffreda. *"Blockchain-based Traceability in Agri-Food Supply Chain Management: A Practical Implementation,"* 2018 IoT Vertical and Topical Summit on Agriculture – Tuscany (IOT Tuscany), 2018

Plagiarism Report

ORIGINALITY REPORT

19%	8%	13%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Qijun Lin, Huaizhen Wang, Xiaofu Pei, Junyu Wang. "Food Safety Traceability System based on Blockchain and EPCIS", IEEE Access, 2019 Publication	10%
2	Qi Tao, Xiaohui Cui, Xiaofang Huang, Angella M. Leigh, Hehe Gu. "Food Safety Supervision System Based on Hierarchical Multi-Domain Blockchain Network", IEEE Access, 2019 Publication	2%
3	Submitted to Daffodil International University Student Paper	2%
4	Qijun Lin, Huaizhen Wang, Xiaofu Pei, Junyu Wang. "Food Safety Traceability System Based on Blockchain and EPCIS", IEEE Access, 2019 Publication	1%
5	www.ethereum.org Internet Source	1%
6	www.quardev.com Internet Source	<1%

7	Submitted to Sim University Student Paper	<1%
8	Submitted to Jacobs University, Bremen Student Paper	<1%
9	scholar.uwindsor.ca Internet Source	<1%
10	Submitted to Victoria University Student Paper	<1%
11	eic.ipo.noaa.gov Internet Source	<1%
12	arxiv.org Internet Source	<1%
13	A. Ravishankar Rao, Daniel Clarke. "Perspectives on emerging directions in using IoT devices in blockchain applications", Internet of Things, 2019 Publication	<1%
14	Submitted to CSU, San Jose State University Student Paper	<1%
15	Submitted to Curtin University of Technology Student Paper	<1%
16	www.isl21.org Internet Source	<1%
	Submitted to Cranfield University	