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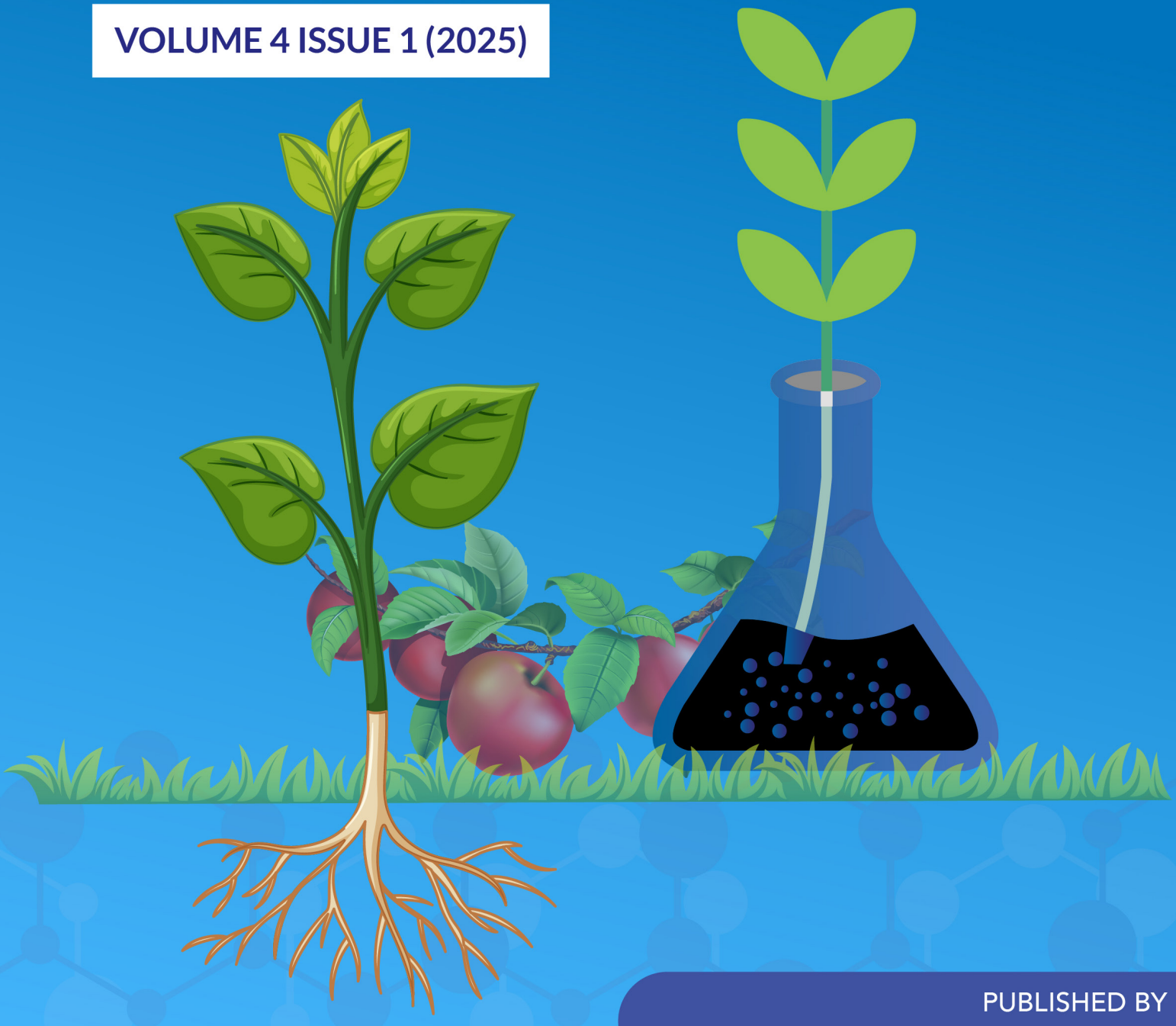

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Integration of Data Science and Block Chain to Secure Food Safety in Bangladesh

Prasenjit Sarker[1*], Chironjit Sarker[2], Khadija Huq[3]

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ABSTRACT

Accessibility to safe food & nutrition is sin-qua-non for physical & mental health. Ironically, securing safe food & nutrition has been going concern around the world. World Health Organization (WHO) states that 1.6 million people worldwide become ill every day from contaminated food caused by bacteria, viruses, parasites. In Bangladesh, this issue is very severe to light upon instantaneously. Most of the food stuffs manufactured and processed in Bangladesh are unsafe for consumption or adulterated to varying degrees. Excessive use of formalin & DDT in food along with toxic colour in food and unhygienic food handling are the significant reasons of cancer specially breast cancer, liver cancer, & pancreatic cancer along with adverse effects on reproductive issue & child mortality. Besides, factories for counterfeit products including chocolates, milk, oils , cosmetics of branded companies have been found in all most every district of country. The purpose of our study is to understand the current scenario of food contamination at every level of supply chain as well as to explore how data science & block chain can be coined together to ensure food safety for consumers. Like the densely population, different confrontations for examples sluggish law enforcement, ignorance, social security, lower economic pattern have to be solaced down to develop proper frame work to secure food safety in Bangladesh.

INTRODUCTION

Securing food safety is very hard nut to crack down especially in densely populated country like Bangladesh. Though good food is prerequisite for good health, stakeholders involved in every level of food supply chain are not concerned enough to secure food safety rather they commit themselves into different dimensions of food contamination as proper law enforcement along with market monitoring, ethics and morality are absent in this regard.

The excessive contamination of food jeopardizes health issue at severe stage causing cancer, kidney disease, and skin disease etc. No steps come to fruition unless the state considers this issue as concerned factor.

Our study endeavors to explore the root causes behind food adulteration, pitfalls of state management, syndicate business etc. Moreover, Integration of data science & block chain technology may bring this problem to fruition.

Research Objectives

This research endeavors to explore

a) The current scenario of food contamination as well as counterfeit products of Bangladesh

b) How Data Science & Block Chain can be combined together to secure food safety & ensure authentic consumable goods.

Scope of the Study

This study delves into finding out the process & developing data base management that will help to extract current scenario of food contamination at every level of supply chain in the agro-based products largely sold out in an open space called bazaar in Bangladesh. It can connect administration, ministry, law enforcement department & other assigned departments under a same umbrella. Additionally, this study may also help out to correlate other sub continental markets like India, Sri Lanka or other countries facing same kinds of challenges & desiring solution to secure food safety.

LITERATURE REVIEW

Food has been contaminated at every level of supply chain (Noman, 2013). Our study fills the gap of that study by developing central data base module that the records of every participants of the supply chain will be centrally stored that may lead to strong law enforcement as data is always available.

Different challenges faced by entrepreneurs specially at supply chain management to initiate a start –up (Sarker, 2020). In our study, a central data base will be proposed. This data base will be connected & conducted by government administration and every player of the supply chain will be under surveillance that will definitely reduce the risks of supply chain especially for entrepreneurs.

A comprehensive model including real time keeping system, different types of QR models etc can contribute food supply chain management using block chain (Asha *et al.*, 2020). Our study will propose a model that will very adaptive for Bangladeshi market.

Different challenges including budgetary constrain to develop block chain & data science technology include data mining challenges as growing surge of data around the world (Chen *et al.*,2019).Our study proposes how

[1] Janata Bank PLC, Bangladesh
[2] Department of Accounting, University of Dhaka, Bangladesh
[3] Foreign Teacher, The Camfirst School, Cambodia
[*] Corresponding author's e-mail: prasenjitsarker48@gmail.com

budget for centrally developed data base management along with data science & block chain can be coined with national budget.

Several measures for example Radio Frequency Identification (RFID), tamper proof protected system, shared data etc can play vital role to adopt block chain technology in live stock farming (Patel *et al.*, 2023). Our study will propose adaptive measures to all levels of supply chain management in agricultural sector.

IOT (Internet of Things) refers a network of physical objects that are connected to the internet & can exchange data with other devices & system (Ping *et al.*, 2018). In our study, we endeavor to explore how IOT will help us to work on developing proper supply chain management with private ledger with controlled network.

The convergence of data science & block chain explores several benefits of data science & block chain while coined together like security & privacy, credibility & transparency, data sharing, protection of data sovereignty (Peng & Liu, 2020). In our study will extract how convergence of data science & block chain contributes record keeping system of distributed ledger to secure food safety at every level of supply Chain Management.

Block chain technology can contribute agro-food supply chain (Shahid *et al.*, 2020).Our study endeavors to find out how integration of data science & block chain will create private distributed ledger for the commercial private factories to prevent counterfeit products on large scale.

Several opportunities & challenges of block chain technology should have been explored on large scale (Zheng *et al.*, 2018).Our study will find out different challenges to implement block chain technology in the context of agricultural based food supply chain of Bangladesh.

There is insufficiency of tags' description of safe food in Bangladesh (Shehen, 2024). Our study will explore encryption method in which data base incurs all information about food supply chain participants.

MATERIALS AND METHODS

To examine the research objectives, this study includes both qualitative & quantitative measures.

Research Design

Qualitative Measures

In data collection process, qualitative data have been collected & analyzed from different sources for examples- various journals, books, business magazines , internet etc.

Quantitative Measures

In this study, quantitative measures have been conducted using several statistical tools for example- mean, media, mood, and regression & correlation analysis along with some computational tools including MS Office, SPSS etc. Besides, several interviews of assigned persons have been conducted at field levels of the administrations. To explore the current scenario of food contamination of Bangladesh, several hypotheses testing have been done to understand what factors actually instigate the all level of suppliers to commit food contamination. To test those hypotheses, 330 respondents have been met to give their insights on the interval scale weighted 1 for very negative response & 5 for very positive scale. Moreover, z-test along with 95 percent confidence level have been done.

H0: Amoral mentality does not instigates food contamination

H1: Amoral mentality instigates food contamination

Dependant Variable

Food Contamination

Independent Variable

Amoral Mentality

H0: Weak law enforcement does not encourage level of corruption of food suppliers

H1: Weak law enforcement encourages corrupted food suppliers

Dependant Variable

Corruption of food suppliers

Independent Variable

Law enforcement

H0: Assigned authorities does not lack proper technological knowledge to secure food safety

H1: Assigned authorities lack proper technological knowledge to secure food safety

Dependant Variable

Proper technological knowledge

Independent Variable

Food security

H0: Agricultural Sector does not fail to attract educated entrepreneurs to secure food safety

H1: Agricultural Sector fails to attract educated entrepreneurs

Dependant Variable

Food safety

Independent Variable

Educated Entrepreneurs

Table 1: Hypotheses Testing Framework

Statement	Scale/ Question	Distribution Table	Confidence Level	Test Type	Sample Size
Amoral mentality does not instigate food contamination	Likert Scale	Z-Test Distribution Table	95 Percent	One -Tailed	330

Weak law enforcement does not encourages corrupted food suppliers	Likert Scale	Z-Test Distribution Table	95 Percent	One -Tailed	330	
Assigned authorities does not lack proper technological knowledge to secure food safety	Likert Scale	Z-Test Distribution Table	95 Percent	One -Tailed	330	
Agricultural Sector does not fail to attract educated entrepreneurs	Likert Scale	Z-Test Distribution Table	95 Percent	One -Tailed	330	
Statement	**Strongly Disagree (1)**	**Disagree (2)**	**Uncertain (3)**	**Agree (4)**	**Strongly Agree (5)**	**Sample Mean**	**Standard Deviation**
Amoral mentality does not instigate food contamination	187	98	2	27	16	1.74	1.12
Weak law enforcement does not encourages corrupted food suppliers	249	55	1	15	10	1.43	.94
Assigned authorities does not lack proper technological knowledge to secure food safety	173	86	16	41	14	1.9	1.35
Agricultural Sector does not fail to attract educated entrepreneurs	193	79	8	27	23	1.81	1.53

Table 2: Hypothesis Testing Formula

Sample Mean ($\bar{x}$)	**Standard Deviation**	**Upper Limit**	**Lower Limit**
$\sum xi/n$	$\sqrt{(x- \bar{X})2/n-1}$	$\mu+Z$(standard deviation/$\sqrt{n}$)	$\mu-Z$(standard deviation/$\sqrt{n}$)

Sample Size Determination

For Large Population: $n= Z^2.p.(1-p)/E^2$ (95% Confidence Level ,5% margin of error& p is 0.5) $n=1.96^2.0.5.05/0.05^2$ =384.16 people needed. In our survey, 55 persons have not responded. Consequently, 330 respondents are considered to be sample size

RESULT AND DISCUSSION

The Current Scenario of Food Contamination as well as Counterfeit Products of Bangladesh

Accessibility to good food is becoming very hard nut to crack down in Bangladesh. Since Bangladesh is a very densely populated country, to secure food safety is very challenging as there is no environmental plan, proper law enforcement, poor literacy etc. About more than 3500-4000 tones of solid wastes per day from industrial discharge, fossil fuels , sewage sludge and municipality waste have been generated in Dhaka city. Consequently, these heavy metals like arsenic, cadmium, chromium,

Table 3:

Contaminants	**Ill-Purpose**
Formalin	Preservation of Fish, Meat, Milk
Calcium Carbide	Fruit to ripen
Brick Dust	Chili powder
Urea	To whiten rice & puff rice
Saw Dust	Loose tea
Melamine	Milk Powder
Soap	Ghee
Artificial Sweetener, coal tear & textile dyes	Sweetmeat
Sulfuric Acid	Milk Condensation
DDT	To dry fish
Ethylene Oxide	To ripen Bananas, papaya and other fruits

copper, lead, mercury etc are absorbed by vegetables through soil and cause serious health diseases like cancers, kidney failure etc. According to Public Health Laboratory of Dhaka City Corporation, proportionate contaminated food items ranges from 70 to 90 percent. More than 76 percent food items in the market have been found adulterated. Moreover, According to the International Centre for Diarrhea Disease & Research , Bangladesh, 50 percent of the food samples (over 150 items of random – test) were found adulterated. In agricultural sector, textile dyes are spread on fish (a very vital source of protein), vegetables, fruits etc.

Approximately, 30 million people experience at least one form of food borne disease each year in Bangladesh (Al Banna *et al.*,2021) , Nevertheless, the food safety system & the regulatory framework in the country are still in their fancy (world university)

To explore the current scenario more transparently, we have conducted hypothesis test with the raw data collected from different respondents involved in different levels of food supply chain.

H0: Amoral mentality does not instigates food contamination

H1: Amoral mentality instigates food contamination

Dependant Variable: Food Contamination
Independent Variable: Amoral Mentality

To test this hypothesis, Likert Scale, very essential for attitude testing, has been used where strongly disagree has been given the weight 1 and strongly agree has been given the weight 5 as well. On the basis of the weight, the hypothesis can be rewritten as below:H0: $\mu = 4$H1: $\mu < 4$To test this hypothesis, agree with the statement given to the 55 respondents has been given the weight 4.Subsequently, the calculated sample mean($\bar{X}$) is 1.72 with the standard deviation of 1.044 and the test has been conducted with the 5 percent significance level.

Lower Limit

μ-Z(standard deviation/$\sqrt{n}$)= 4-1.65(1.12/$\sqrt{55}$)=4 -0.1017= 3.89

z-Test: Two Sample for Means

Table 4:

Column1	Variable 1	Variable 2
Mean	1.748484848	0
Known Variance	1.27	0.000001
Observations	330	1
Hypothesized Mean Difference	4	
z	-36.28888017	
P(Z<=z) one-tail	0	
z Critical one-tail	1.281551566	
P(Z<=z) two-tail	0	
z Critical two-tail	1.644853627	

Result

This test has been conducted as left one tailed z test where as sample mean ($\bar{X}$) 1.7484 which is lower than lower limit i.e 3.89 & belongs to the area of the rejection. Moreover, Critical Value< Z value; -1.2815< 36.288. So, It can be concluded that H0 (null hypothesis) is rejected & consequently, Ha (alternative hypothesis) is accepted. So, It can be said that "Amoral mentality instigates food contamination".

H0: Weak law enforcement does not encourage level of corruption of food suppliers

H1: Weak law enforcement encourages corrupted food suppliers

Dependant Variable: Corruption of Food Suppliers
Independent Variable: Law Enforcement

Table 5:

Column1	Column2	Column3
z-Test: Two Sample for Means		
	Variable 1	Variable 2
Mean	1.43030303	0
Known Variance	0.89	0.000001
Observations	330	1
Hypothesized Mean Difference	4	
z	-49.47244549	
P(Z<=z) one-tail	0	
z Critical one-tail	1.281551566	
P(Z<=z) two-tail	0	
z Critical two-tail	1.644853627	

Lower Limit

μ -Z(standard deviation/$\sqrt{n}$)= 4-1.65(.94/$\sqrt{330}$)= 4 -0.085= 3.915

Result

This test has been conducted as left one tailed z test where as sample mean ($\bar{X}$) 1.43030 which is lower than lower limit i.e 3.91 & belongs to the area of the rejection. Moreover, Critical Value< Z value; -1.2815< 49.47. So, It can be concluded that H0 (null hypothesis) is rejected & consequently, Ha (alternative hypothesis) is accepted. So, It can be said that "Weak law enforcement encourages corrupted food suppliers"

H0: Assigned authorities does not lack proper technological knowledge to secure food safety

H1: Assigned authorities lack proper technological knowledge to secure food safety

Dependant Variable: Proper Technological Knowledge
Independent Variable: Food Security

Table 6:

Column1	Column2	Column3
z-Test: Two Sample for Means		
	Variable 1	Variable 2
Mean	1.9	0
Known Variance	1.82	0.000001
Observations	330	1
Hypothesized Mean Difference	4	
z	-28.27490806	
P(Z<=z) one-tail	0	
z Critical one-tail	1.281551566	
P(Z<=z) two-tail	0	
z Critical two-tail	1.644853627	

Lower Limit

μ -Z(standard deviation/√n)= 4-1.65(1.35/√330)=4 -0.1226= 3.8774

Result

This test has been conducted as left one tailed z test where as sample mean ($\bar{X}$) 1.9 which is lower than lower limit i.e 3.8774 & belongs to the area of the rejection. Moreover, Critical Value< Z value; -1.2815< 28.274. So, It can be concluded that H0 (null hypothesis) is rejected & consequently, Ha (alternative hypothesis) is accepted. So, It can be said that Assigned authorities lack proper technological knowledge to secure food safety

H0: Agricultural Sector does not fail to attract educated entrepreneurs to secure food safety

H1: Agricultural Sector fails to attract educated entrepreneurs

Dependant Variable: Food safety

Independent Variable: Educated Entrepreneurs

Table 7:

Column1	Column2	Column3
z-Test: Two Sample for Means		
	Variable 1	Variable 2
Mean	1.812121212	0
Known Variance	2.34	0.000001
Observations	330	1
Hypothesized Mean Difference	4	
z	-25.98015141	
P(Z<=z) one-tail	0	
z Critical one-tail	1.281551566	
P(Z<=z) two-tail	0	
z Critical two-tail	1.644853627	

Lower Limit

μ -Z(standard deviation/√n)= 4-1.65(1.53/√330)=4 -0.138= 3.862

Result

This test has been conducted as left one tailed z test where as sample mean ($\bar{X}$) 1.81 which is lower than lower limit i.e 3.862 & belongs to the area of the rejection. Moreover, Critical Value< Z value; -1.2815< 25.980. So, It can be concluded that H0 (null hypothesis) is rejected & consequently, Ha (alternative hypothesis) is accepted. So, It can be said that Agricultural Sector fails to attract educated entrepreneurs.

In Bangladesh, negative societal attitude, lack of technological innovations, venture capital fund unavailability, political instability are triggered as challenges to attract educated entrepreneurs in agricultural sector(sarker,2020). Without proper education & trainings moral values, food safety can't be ensured as the reasons being that the maximum participants in the supply chain lack of proper education, moral values and directed by extreme materialism.

Hypocrisy Directed by Lack of Moral Values

All participants involved in the supply chain give their consent not to support any food contamination at any level of supply chain while selling or manufacturing consumable goods. Ironically, they shift liabilities on other head and claim themselves to be honest even after being exposed to be involved in food contamination , which is, to some extent, related to Psychological term " Hypocrisy". Occurrence of hypocrisy when the by society most despised types pretend to be the most revered type (Hallman & spiro, 2022). In Bangladesh, maximum people pretend to be honest by maintaining their religious values & other morals but maximum business are disguised in the name of religion and they commit food contamination, unethical food stock only for seeking more profits jeopardizing the health of consumers to very severe state.

State has become completely failure to raise real ethical values since childhood though various educational institutions are working to build morals but people of all levels accepts morals for others not for themselves. Lack of resources, poor human resource management, poor technological innovation, over population problems are the facts should be come into fruition.

State along with proper law enforcement authorities should move forward to make stance against suppliers in food supply chain involved in food contamination. Several psychological studies are recommended to be done about the psychological state of the people of Bangladesh in a large frame even if it is a very long term process but it will make sense in future to direct a nation in a unified way.

Combination of Data Science & Block Chain to Secure Food Safety as well as to Ensure Authentic Consumable Goods

Technological Surge:Data Science & Block Chain

The escalating of data generation in contemporary society has fueled innovation while raising concerns

about the security and transparency of data transaction (Tatineni &Boppana, 2021). This research delves into synergy between data science & block chain to safeguard food safety at every level of supply chain along with data integrity and unprecedented data transparency as well.

The ceaseless surge of data generation in the contemporary world necessitates the data insightfulness from big data to be mined out. Data mining significantly plays pivotal rule to extract the effective data to understand the real problem as well as to design effective module as comprehensive solution.

Ciphering involves both data encryption and data decryption using the mathematical algorithm to secure data integrity and data transparency. This process transforms readable data into unrecognizable form called cipher text. Subsequently, the conversion of cipher text into plain text is called decryption. Moreover, private key is widely used for encrypting data and private key is used for decrypting data remaining very secret & non recoverable if forgotten.

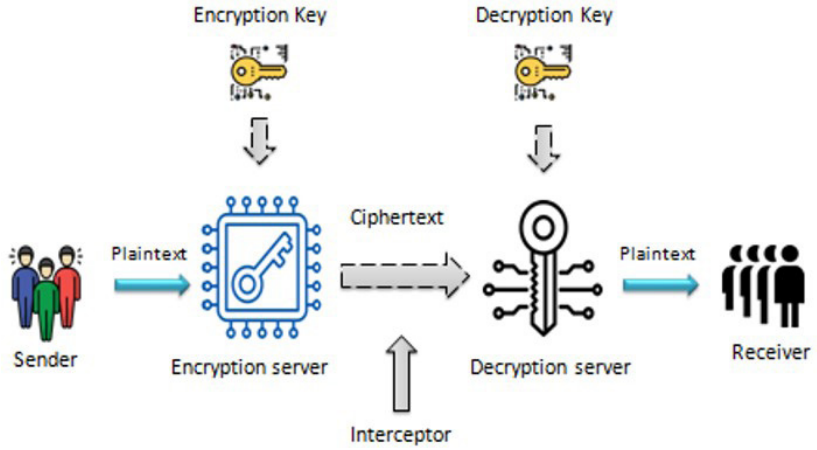

Figure 1: Process of Block Chain Technology

Types of Encryption

Symmetric Encryption

Symmetric Encryption, less secured than asymmetric encryption, uses a single key for both encryption and decryption. It is often used for encrypting data stored locally.

Asymmetric Encryption

Asymmetric Encryption uses two keys called public key and private key. Moreover, public key is used for encrypting data and private key is used for decrypting data. It is more resistant to cyber attack and more flexible as it involves only two parties.

Although, It is more complex than symmetric encryption, It allows to create digital signature used to verify the authenticity and integrity of a message file.

Block Chain

A block chain is a distributed database or ledger that maintains ceaseless progressing lists of ordered records called bocks. Cryptography links each block using cryptography and every block contains the cryptographic hash of previous block, a timestamp, and data transaction.

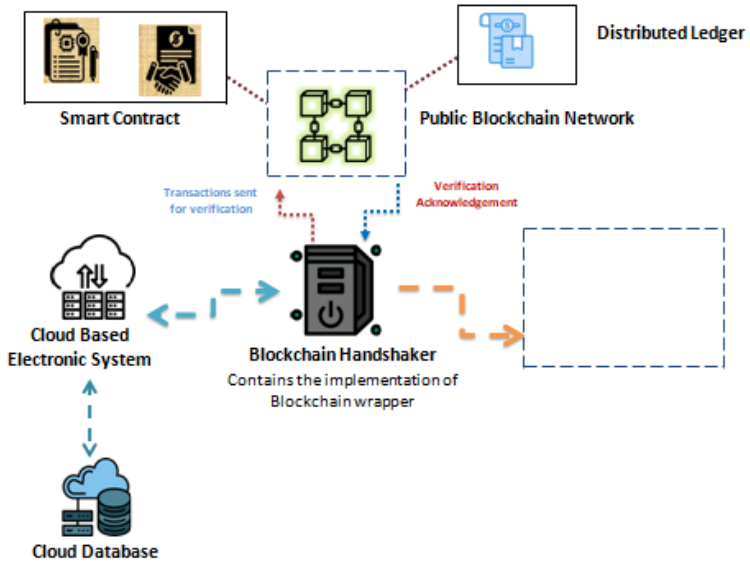

Figure 2: Block Chain Technology along with distributed Ledgers

In 2008, Satoshi Nakamoto invented block chain to serve as the ledger of public transaction related to crypto currency bitcoin- first digital currency to solve the double –spending problem without need of central server or trusted authority.

Blockchain originated as a result of bitcoin , a technological innovation that is a sent out data source along with the constantly improving files viewed as block. Furthermore, It is always expanding as brand new blocks are put by miners to it (every ten minutes) to capture the newest transaction .Block chain is the process of decentralization which gives each party the right to access the entire database and can verify the record throughout the entire database without involving of middleman or single party control. Block chain technology is the unprecedented solution for data security .Fabrication or temperament of data seems to be near to impossible in system as every node records all data. If any sort of data twisting happens, it must be verified by the all participants of the ledgers using hashing which interlinks previous link to next block.

Data Science & Block Chain Integration

The surge of data science technology is fueling the risks of data management at similar pace. Data leakage, data temperament, low quality of data needs to be addressed in data risk management. Data science relates to block chain with high data quality, traceability, built in anonymity & large data volume(Hussain & kishoth,2022).Block chain technology is the comprehensive solution for aggravating risk of data management. In case of data sharing, block chain technology brings point to point transmission, consensus mechanism, and encryption algorithm as well as the solution for the data risk management. Block chain technology ensures data security, data privacy, data credibility, data transparency, and protection of data sovereignty (Peng & Liu,2021). Although the integration of data science and block chain technology is growing faster, It still involves some challenges for example data scalability, data accuracy, data insightfulness etc.

Data Scalability

In data science technology, a lot of data needs to be sorted out , processed and analyzed called data mining. A large scale of data needs large storage capacity. Sometime it seems to be very difficult to manage a large number of data from big data which incurs costs for research & development and incapacitates the company to thrive out competitive advantage.

Although block chain brings many advantages that other technology doesn't have, it is still exposed to scalability issue that prevents real time trading (Caret *et al.*, 2017).

Data Accuracy for Research & Development

The immense protection of data some time obstructs researchers to get the real & accurate data which is very important to predict future market and make decision over current market as well. The integration of data science & block chain constructs very sophisticated network in which mining data for predictive analysis is very challenging. It is still very hard nut to crackle to extract real data insights from big data for accurate market analysis. A large number of data sets require more secured storage. The verification process in the distributed ledger & auditing of big data are still challenging (Aujla *et al.*, 2022).

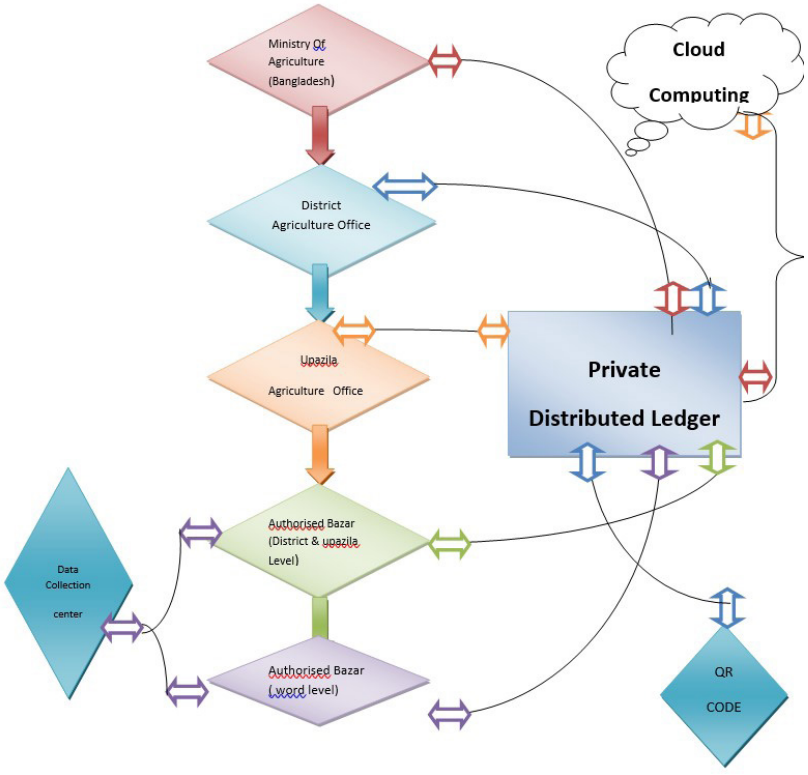

Figure 3: Proposed Model integrating Data Science & Block Chain

According to Shehen (2024), tags' descriptions of safe food are insufficient in Bangladesh.A model integrating data science & block chain has been proposed where a centralized data base monitored and handled by government stores all sets of data incurred from the stakeholders involved in the whole supply chain. Here, in a proposed model, concerned ministry of government is linked with all components of chain of command maintaining proper protocol including district level to upazila level. Moreover, all buyers & sellers should be enlisted in to their concerned authority of their business area & should provide all necessary information about product for example where he collects his / her products from? A data collection center should be existed in the bazaar which collects data from sellers & buyers end (in wholesale market). The whole data base should be linked with centralized data base (private distributed ledger) solely controlled by ministry of agriculture.

Besides, ministery should provide QR-code marked eco friendly shopping bags for end level consumers by which consumer can access to all data regarding the products including manufacturer, whole seller, retailer, product specification etc. This shopping bags should be provided by enlisted data collection center & bazaar monitoring cell who will collect information about businessmen involved in that bazaar & distribute that QR-code marked shopping bags which will provide the information about businessmen at bazzar level collecting from the mother database controlled by ministry level.

Step by Step Progression

➢ Setting up Data Collection center at every bazzar (Whole sale & Retail perishable goods market)

➢ Enlisting categorically all whole sale sellers & wholesale buyers and giving them registration number specified for specific place i.e. no one can use registration number for more than one bazzar/ markets

➢ In whole sale market, buyers & sellers both provide information about products for example- who does he / she purchase product from ? or who does he/she sell the products to?

➢ In wholesale market buyers gets QR marked bags provided by ministry containing all information about seller

➢ In retail market, consumer (end customer) gets the QR marked bags containing all information about manufacturer, whole seller & retailer as well.

By doing all that, consumers at end level can get to all information about products & easily claim about involved party if any sort of food contamination occurs. This process can be revolutionary step to stance against food contamination. In addition, law enforcement authority can easily trace out which party is directly engaged with the food contamination and ensure punishment in a perfect way. Due to this process, there will be no room for passing one's sinful responsibility on other's neck.

CONCLUSION

In this study, we endeavor to explore the current scenario about food safety in Bangladesh. Besides, by ensuring the proper process of the proposed model will certainly ameliorate the current situation of food safety of Bangladesh and definitely will contribute to ensure transparency, integrity, proper law enforcement and commitment towards consumers. A proper stance against food contamination will lead to ensure sound health & mind as well & obviously reduce medical expenses & health hazards as well.

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