UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING & INFORMATICS

BLOCKCHAIN READINESS ASSESSMENT FOR DOMESTIC HORTICULTURE TRACEABILITY IN URBAN KENYA.

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A research project report submitted in partial fulfillment of the requirement for the award of Masters of Science in Information Technology Management of the University of Nairobi.

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DECLARATION

This research project is my original work and to the best of my knowledge has not been submitted for any other award in any university.

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DEDICATION

I dedicate this project to my lovely wife Anita Matwor, my daughters Pretty Chebet and Patience Cherop for their love, motivation and continued support.

ABSTRACT

Background

The horticultural food industry has been facing a lot of crises globally as the market and demand increases leading to difficulties in control, consumer safety concerns and trust of information.

Problem

To be able to increase the traceability and enhance consumer safety, the information infrastructure has been on constant development and lately is the blockchain technology that has gathered tons of attention as a potential solution to the issues. There is therefore need to establish the level of readiness of horticultural industry actors for blockchain and develop a suitable roadmap for the implementation of blockchain.

Objective

This study sought to investigate the existing traceability systems in horticultural supply chain and assess the level of stakeholders' readiness for blockchain technology.

Methodology

The research was a case study on urban Kenya domestic horticultural supply chain. An online survey was done on actors, phone interviews conducted, theoretical and empirical findings analyzed then used as a guide in development of a roadmap.

Result

The research revealed that the future value of blockchain was perceived by actors to be high however regulations, suitable infrastructure, skills and usage were still at conceptual stages. The developed roadmap provides the initiatives and proposed timelines to assist in implementation of the technology.

Limitation

The study was conducted in the context of domestic horticulture focusing specifically on the urban setup and therefore may not adequately cover the processes in the entire horticultural sector.

Conclusion

The study indicated that usage of blockchain and that the level of readiness in Kenyan horticultural sector is low. The roadmap developed outlines initiatives for implementation based on the gaps identified during the study and review of literature.

Value of Study

This study sought to provide a better understanding on the level of readiness of Policy makers, consumers, innovators, and regulators on blockchain technology and to provide a basis for Implementation of the technology in horticultural supply chain.

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LIST OF ABBREVIATIONS

AFA-Agriculture and Food Authority

BCT-Blockchain Technology

CDC-Centre for Disease Control

CFO-Chief Finance Officer

CIO-Chief Information Officer

CTPs-Critical Traceability Points

DOI-Diffusion of Innovation

DNA - Deoxyribonucleic Acid

FAO-Food and Agricultural Organization

HCD-Horticulture Crops Directorate

HRM-Human Resource Manager

HTS- Horticulture Traceability System

GPS –Global Positioning System

ICT –Information Communication Technology

IoT-Internet of Things

ISO – International Organization for Standardization

KENET- Kenya Education Network

NRI- Network Readiness Index

PBFT- Practical Byzantine Fault Tolerance

PoS-Proof of Stake

PoW- Proof of Work

WEF- World Economic Forum

WHO-World Health Organization

RFID - Radio-Frequency Identification

TOE - Technology Organization Environment

DEFINITION OF TERMS

Actor- includes producers, distributors, consumers and regulators of a food product that must be certified and registered to maintain the trust of food products.

Blockchain Technology- a decentralized and distributed ledger for recording the source of digital assets.

E-Readiness-refers to the degree of preparedness of a country's government, organizations, citizens and businesses to use ICT for sustainable development.

Supply Chain- a link among organizations and their suppliers to produce and distribute products to the consumers. It also represents the steps taken for a product to or a service to move from original state to a customer.

Traceability- ability to identify and track a product or substance as it moves from raw goods to finished product in a supply chain.

CHAPTER ONE: INTRODUCTION

1.1 Background of Study

The quality and safety of the food in the supply chain has been of greatest concern to producers, regulators, distributors and consumers (Kasten, 2019). The increasing cases of food falsification and adulteration have led to huge economic losses, wide-spread loss of trust by consumers, and have become a persistent problem to all stakeholders in the food supply chain (Galvez, Simal, & Mejuto, 2018). Building food supply chain traceability is becoming a key requirement for agriculture based economies.

Current food supply chain has become complex due to increasing competition, diverse policies, regulations, human behavior and cultural diversity make evaluation of information and management of risks in the supply difficult (Saberi, Kouhizadeh, Joseph, & Shen, 2019).

Management of supply chain concerns relationship management of links by links (Lambert & Enz, 2017).

Blockchain technology is the latest innovation in decentralized information technology that offer required traceability and reliable information food supply chain. It guarantees food safety, efficiencies in transactions; reduce food frauds through gathering, dissemination and verification of product information authenticity (Zhang, 2015).

Blockchain can revolutionize the supply chain in terms of risk reduction, dependability, speed, sustainability, quality and flexibility (Kshetri, 2018). (Ndemo, et al., 2019) recommend that the use of emerging technologies like blockchain can streamline the food supply chain and enhance realization of food security among the big 4 agenda in Kenya.

(Iansiti & Karim, 2017), define blockchain as 'peer-peer network with blocks of embedded stored digital codes of transactions tamper-proof and protected from deletion .It uses identifiable signatures that can be easily validated and shared'

It was started in 2008 by Nakamoto to process electronic cash thus solving the double spending and intermediaries' problems by use of online payments.

Currently, it has been adopted for smart contracts management, health insurance and digital identity for citizens by government in developed countries (Luong, 2019).

A survey done on 1500 consumers in United States indicated 75% of food consumers do not trust and do not have access to full information hence they use labels and certifications to make decisions on purchases they make (WEF, 2019)

Frauds on food products are far-reaching and prevalent. FAO describes food fraud as adulteration of food for monetary gains. It includes counterfeiting, dilution, intentional substitution and misrepresentation of processing and distribution of food products subjecting consumers to health risks and loss of confidence.

World Health Organization states that contamination of food results to 1 in 10 people becoming sick and 420,000 deaths reported annually with severity being on developing countries (Hirshfield, 2013).

According to Centre for Disease Control an outbreak of salmonella and Escherichia coli in United States in 2015 as a result of contaminated papayas made consumers ill. The outbreak led to a stock drop by 42% at Chipotle supply chain. This was attributed to failure to monitor and account for supplies on real-time .Prevention, recalls and further outbreaks could not be done (Ravel, et al., 2010).

Globally, over 70 percent of the people in developing countries depend on agriculture to sustain their livelihoods. Just like countries in Sub Saharan African, agriculture is the backbone of Kenya's economy, supporting up to 80% of the livelihoods (KNBS, 2017; FAO, 2016;)

The Kenya horticultural sector has recently expanded from small-holder farmer to large scale export attracting attention of international organizations and consumers. The sector has also grown to be the leading subsector in Kenya's agriculture (Colonna et al., 2013; AFFA, 2014). International food safety institutions play a key role in horticultural sector in ensuring that food safety standards and certifications are followed strictly (Ouma, 2010; MacGregor et al., 2014). Although standards have been stringent, there has been an increasing demand from consumers for the products thus an increase in value of Kenya's horticultural products.

1.2 Problem Statement

Traceability has become an urgent requirement in food and medical products supply chain (Saberi, Kouhizadeh, Joseph, & Shen, 2019).However some companies like IBM have done pilots on verification and validation of food products using BCT in supply chain, implementation is still a major concern (Kharif, 2016). Additionally, the rate of use of BCT is still low (Zhumaev et al., 2018), Accenture (Treat et al., 2017) and IBM (Bear et al., 2016) analysis on usage index in developed countries. Nonetheless, actors see an opportunity in using this technology for traceability and its potential to transform sociotechnical systems hence need to establish their level of preparedness towards BCT in horticultural supply chain in urban Kenya.

1.3 Research Objectives

This research sought to;

i. Review existing traceability technologies in horticultural food supply chain.
ii. Assess stakeholders' level of readiness towards use of blockchain for supply chain traceability using an adopted Framework.
iii. Develop a roadmap which acts as baseline tool for implementation of blockchain in domestic horticulture supply chain.

1.4 Research Questions

i) Which traceability technologies are currently in use in domestic horticulture supply chain?
ii) How prepared are the domestic horticultural supply chain actors in Kenya for blockchain use?
iii) What measures are in place towards use of blockchain technology?
iv) What is the most suitable roadmap for implementation of block chain technology in horticultural supply chain?

1.5 Significance of Study

There have been reports and recommendations by various policy makers on use of emerging technologies towards digital transformation in Kenya .Recently is a report on exploration and analysis of emerging digital technologies for Kenya done by blockchain taskforce in July, 2019. The taskforce recommended use of Blockchain for transparency and value addition in Supply chain. This study therefore sought to provide a better understanding on the level of readiness of Policy makers, consumers, innovators, and regulators on use of BCT for traceability in horticultural food supply chain. It also sought to add knowledge to research and provide actors with a basis for Implementation of the technology in horticultural supply chain.

1.6 Assumptions

This study assumed that the participants gave timely, honest and factual responses on the survey and interview questions and that the selected participants was a true representation of domestic horticulture actors in urban Kenya.

CHAPTER TWO: LITERATURE REVIEW

The chapter presents a review of the existing studies on food supply chain traceability, existing traceability systems, the concept of Blockchain technology and its applications in the food supply chain traceability.

2.2. Food Traceability in the Supply Chain

Traceability involves the keeping track of food materials and other consumable substances information through the processes of production, distribution and final consumption (ISO 22005, 2007)

WHO and FAO legislate that it is either mandatory or optional for organizations to give traceability data to consumers. They also classify product information into; Mandatory data including product Identity, its description, lot number, expiry date, quantities, units, supplier and Optional data for example packaging date, date of dispatch and receipt, contact information and specific origins.

(Silverman, 2018) Mandatory data mostly is inadequate in provision of reliable information to consumers' regarding safety and quality of a food product. If some product specifics are made optional, it results to information asymmetry and little access to traceable information of particular products (Pizzuti & Giovanni, 2015).

Most regulation by WHO and FAO on food are applicable to all UN member states aiming at protecting the health of the public. Food, drugs and chemicals substance Act (2012) (Ken), complements the WHO and FAO regulations. The Regulations states that "processing, packaging , labeling , and distribution of food substances should prevent the consumer or purchaser from being deceived or misled on its quality, quantity, character, value, composition, effect, merit or safety or to prevent injury to the health of the consumer or to purchaser".

(Gichure, Kariuki, Njage, & Wahome, 2016), "the success of implementing traceability is mainly attributed to good organization and personnel perception; and so, does food safety management. These are facilitated by proper documentation (record keeping), compliance to quality management standards, capacity building on food quality & safety and traceability management, as well as proper monitoring of the quality management system".

2.2.1 Information Flow in Food Supply Chain

Flow of information in supply chain is enhanced through creation, sharing and exchange of information which constitute an important part of business (Pant, Gyan, & Farooquie, 2015). Organization's sustainable competitiveness and efficiency is achieved through automation of its external networks and information thus minimizing costs incurred internally on management. This can be achieved when technologies like Internet of Things (IoT) are used (Hepp, Matthew, Philip, Alexander, & Bela, 2018) .

2.2.2. Information Transparency in Food Supply Chain

Information is expected to increasingly become transparent and important as the use of emerging technologies to disseminate information to stakeholders rises, this affect consumer's confidence and sustainable performance of a company (Mol, 2015). Changes attributed to technological wave, social media and changing information scape are embedded on accountability of third parties leading to an increase of stakeholders' awareness as well (Mol, 2015).

Whereas there seems to be a close relationship between transparency and traceability, traceability is perceived to be vertical aspect of the transparency. Traceability allows one to track product moves thus complementing transparency.

Product information transparency creates an ability of availing specific and reliable information to different players without distortion or delays (Korpela, Hallika, & Dahlberg, 2017) .

Efficiency, compliance and quality are the key motivators for information transparency in a food as opposed to contributing to higher level of sales. Food Quality Management and certification directly impacts on consumer's value for profit inspirations (Pozo, Barcelos, & Getulio, 2018).

Food quality, regulations, technology, collaborative information sharing and societal impacts are other attributes that inspires towards significant transparency and execution of traceability systems (Gunasekaran, et al., 2016).

2.3. Food safety

Food safety entails processing, transportation, management and storage of food in a clean manner so as to prevent diseases among consumers (CDC, 2018). CDC states that 48m Americans become ill annually due to contaminated food resulting to 3,000 deaths. According to studies done by Oceana in 2016 on seafood fraud, 20% of the food is not correctly labeled.

With increasing cases of food adulteration and scandals of food products that are highly perishable like dairy products, food safety has emerged a key challenge to deal with. Despite more attention by government, regulators and organizations, suppliers have ended up investing highly towards assurance systems, meeting market demands as well as attain food safety and quality requirements (Ababio, Patricia, & Pauline, 2015).

World Health Organization (WHO) approximates that 600 million people become sick resulting to 420,000 deaths annually as a result of consuming contaminated food. Developing countries like Kenya being among the leading in the reported cases. The issue is of great concern globally.

(Gebresent, 2015), to increase trust, reduce expenses incurred on identification of causes of food insecurity and exposures to consumers, the networks for distribution should be designed in a way that wholesalers and consumers have the ability to trace back products, initiate recalls, withdrawals and submit reports in an event of a product alarm.

(Karsen, Donnely, & Olsen, 2011), stated that there is the risks of losing information as a result of failing to link processes to systems that contributes to traceability. They developed a model called a Critical Traceability Points 8 (CTP's) for assessing and linking processes to traceability systems so as to minimize the risk of information loss.

(Septiani, Winnie, Yeni, & Liesbetini, 2014), came up with four classifications of risks in a dairy supply chain; risks on Demand, risks on Supply, Disruption risk and Process breakdown risk.

2.3.1 Trust.

(Sayogo, et al., 2015), standards, certifications and regulations by government and other Non-governmental actors are key elements towards trust making. The study also put emphasis the data providers faces a major challenge of delivering information that is credible and simple. Performance and success are enhanced by building Transparency and trust in relationships thus increasing performance and overall success. Trust is however immeasurable and not tangible but the incentives must be clearly stated for all players to measure transparency by use of methods like use of block chain technology (Holmberg & Aquist, 2018) Increase in traceability improves quality management, identifies and communicates noncompliance and thus impacts positively on consumers trust and expectations (Pizzuri & Mirabelli, 2015).

(Chen, 2014), highlights that a culture for active participation by all employees in an organization forms part of vital element in integrating supply chain and food control systems.

2.3.2 Consumer Awareness

(Aung & Chang, 2013), Stated that as need for consumer awareness increases, companies in food industries should comprehensively apprise consumers on other aspects like source, processes, safety, methods of production, quality and environmental impacts. Traceability visualizes these aspects thus increasing informing and increasing the consumers' confidence and satisfaction. (Mol, 2015) Collaboration and teamwork between actors contributes significantly to traceability and transparency.

Information asymmetry resulting from limited and inadequate awareness of the health, societal and ecological effects based on consumer decisions. Companies may as well have little awareness of a product information through the supply chain (Sayogo, et al., 2015) Information asymmetry can be eliminated by interactions in supply chain .Firms with greater ability and enhanced interactions can lessen the asymmetry through collection of information, shortening communication distance, cultural and societal believes (Sarkis, Qinghua, & Kee-hung, 2011).

2.4 Food Traceability Systems

(WEF, 2019) Traceability systems help in tracking of health, economic and societal impacts of various agricultural products through a supply chain leading to cost reduction and optimization.

A worthy traceability system is efficient minimizes losses and damages. In best practice, it enhances data access hence good quality management. It records and keep track of products journey through production, processing, distribution up to consumption (Dabbene, Gay, & Tortia, 2014).

Studies done by (Wang & Huili, 2017) indicated that a cautionary system that is useful to managers in identification of risks ,reduction of production costs and efficient decision making can be developed using IoT-technology. It can also be used for early detection of risks associated with food safety and information sharing between in the food supply chain.

2.5 Existing Food Traceability Systems

2.5.1 Internet of things (IoT)

This a machine to machine structured way in which the application, network and perception layers used for data storage, sensing and manipulation communicates.

Use of Internet of Things (IoT) to mitigate on transparency concerns in supply chain is considered to be associated with high costs because of the complexity in collaboration of systems .It also requires continuous and regular updates of services (Kaloxylos, 2013).

IoT provides real-time visibility to the flow products, hence optimize and transforms business processes. Use of IoT in a supply chain provides a lot of advantages like flexibility, transparency and effectiveness. The downside of IoT is on continuous data flow storage, analysis, synthesis and presentation (Haddud, 2017).

Even though IoT has been widely adopted, security, threats, data manipulation and attacks are still major concerns attributed to immature standards and secure software and hardware design. (Kahn & Salah 2018). Lack of knowledge on cost benefit and investment costs in organizations is another challenge facing the use of IoT (Tzounis et al., 2017).

There has been a general trend of perishable products like milk in the market hence there is need of new technologies use in repositioning of economy's competitive advantage as the environment becomes competitively complicated (Mattila & Holmstron, 2016).

2.5.2 Radio Frequency Identification and GPS–based traceability systems.

Many researchers have studied and proposed various methods, models and frameworks for enhancing traceability of food products. Other studies have considered use of Radio Frequency Identification (RFID) technologies for tracking of food materials. (Pant, Gyan, & Farooquie, 2015) Suggests the incorporation of GPS location monitoring systems while (Galimberti, et al., 2013) designed a DNA system for barcoding. All these studies focuses on collection and sharing of information but doesn't indicate clearly how information asymmetry and effective traceability will be achieved and how further traceability systems can be used for pre-warning ,detection and dissemination food safety information to consumers (Wang & Huili, 2017).

2.6 Overview of Blockchain Technology

Blockchain is considered as a distributed ledger based technology for processing and verification of digital data transactions between actors in network. A blockchain permits various levels of access; private, public, consortium or public which uses various kinds of architectures including; decentralized, centralized or distributed (Zheng, Zibin, Shaoan, Hongning, Xiangping, & Huaimin, 2017)

Figure 1: Categories of Blockchain Network Architecture

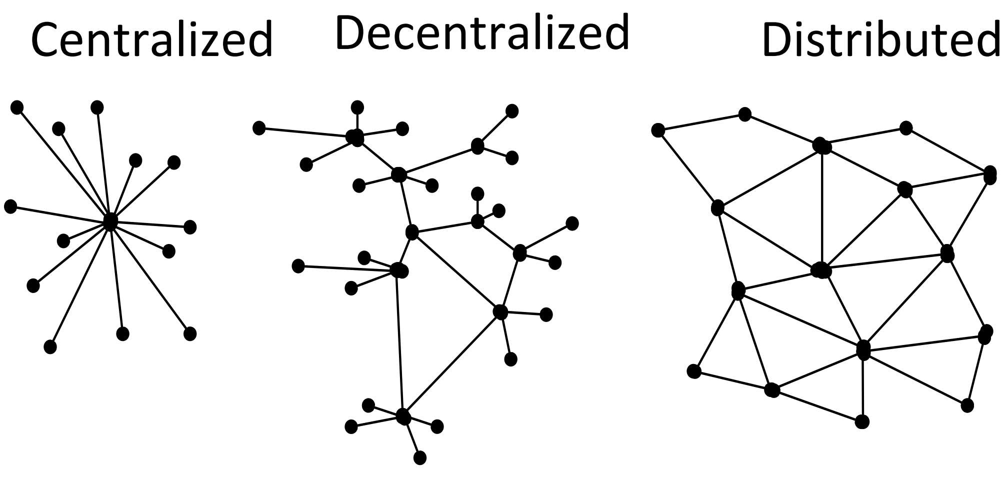

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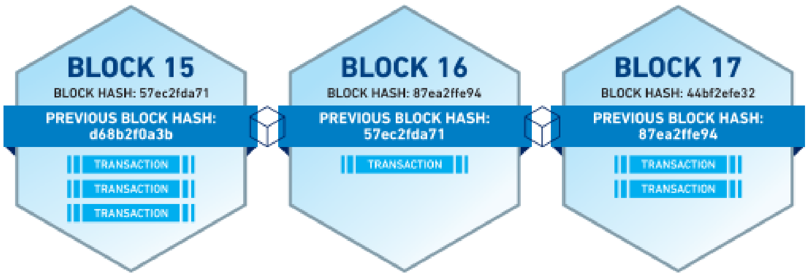
Figure 2: High Level Blockchain Structure



Source :(Blockchain Ecosystems, Garner, March 2018)

2.6.1 How Blockchain Works

Blockchain constitute a series of blocks of storage platform and digital data represented in a 7 steps process flow (Bhardwaj, Vashist, & Vora, 2019) .

Table 1: Blockchain Operation Steps

Step	Operation
1.	A transaction is registered
2.	Transaction is recorded in the shared ledger
3.	Blocks are disseminated to all actors
4.	Actors approve the valid transactions
5.	A Post consensus block is added to chain
6.	Authorized actors confirm the actual state of blocks.
7.	Chain is displayed to all peers in single view

Source: International Research Journal of Engineering and Technology (IRJET), (Bhardwaj, Vashist, & Vora, 2019)

2.6.2 Approaches used in Blockchain

There are five concepts that are key to blockchain which includes; Access, optimization, Consensus protocol, Distributed architecture and Keys. The consensus protocols uses Proof of Work (PoW),) Practical Byzantine Fault Tolerance (PBFT) and Proof of Stake (PoS) theories and private and a public key authentic transitions (Future, 2017). Consensus protocols secure transactions however its time and energy consuming, the concept of Merkle tree is used for optimization (Burkhardt, Daniel, Maximilian, & Heiner, 2018).

Table 2: Explanation of Concepts

Concept	Category	Description
Access	Private	Is centralized and controlled by one organization that meets requirements.
	Public	A distributed Open network which allows networked actors to transact and participate in consensus process (Lin et al. 2017).
	Consortium	Integration of public and private chain of permissioned actors leading to a hybrid model (Gramoli 2017).

Keys	Private	Privately owned and used to confirm account transactions (Future, 2017)
	Public	Used for addressing of specific nodes for interaction with other nodes in the network (Kairos Future 2017).
Architecture	Centralized	Comprises of all the data hosted at a single point (Larsson, 2017).
	Decentralized	Uses consensus protocol for spread of data that is spread in several locations globally
	Distributed	Gives a framework of copies of data in several network nodes (Pehrson n.d).
Consensus protocols	Proof of Work (PoW)	Consensus protocol that uses 'mining" concept to confirm and validate a transaction. It is a difficult process that consumes a lot of time and energy (Auer, 2019).
	Proof of Stake (PoS)	PoS is used for approval and validation of transaction using the digital wallet concept. (Zheng, Zibin, Shaoan, Hongning, Xiangping, & Huaimin, 2017).
	Practical Byzantine Fault Tolerance	A procedure that tolerates faults effectively .it uses two nodes and a three process stages; pre-preparation, preparing and committing a transaction (Abraham, et al., 2017).
Optimization	Merkle Tree	A data structure cryptocurrencies for encoding and securing blockchain data efficiently (Mukhopadhyay, et al., 2016).

2.6.3 Blockchain in horticultural Food Supply Chain globally.

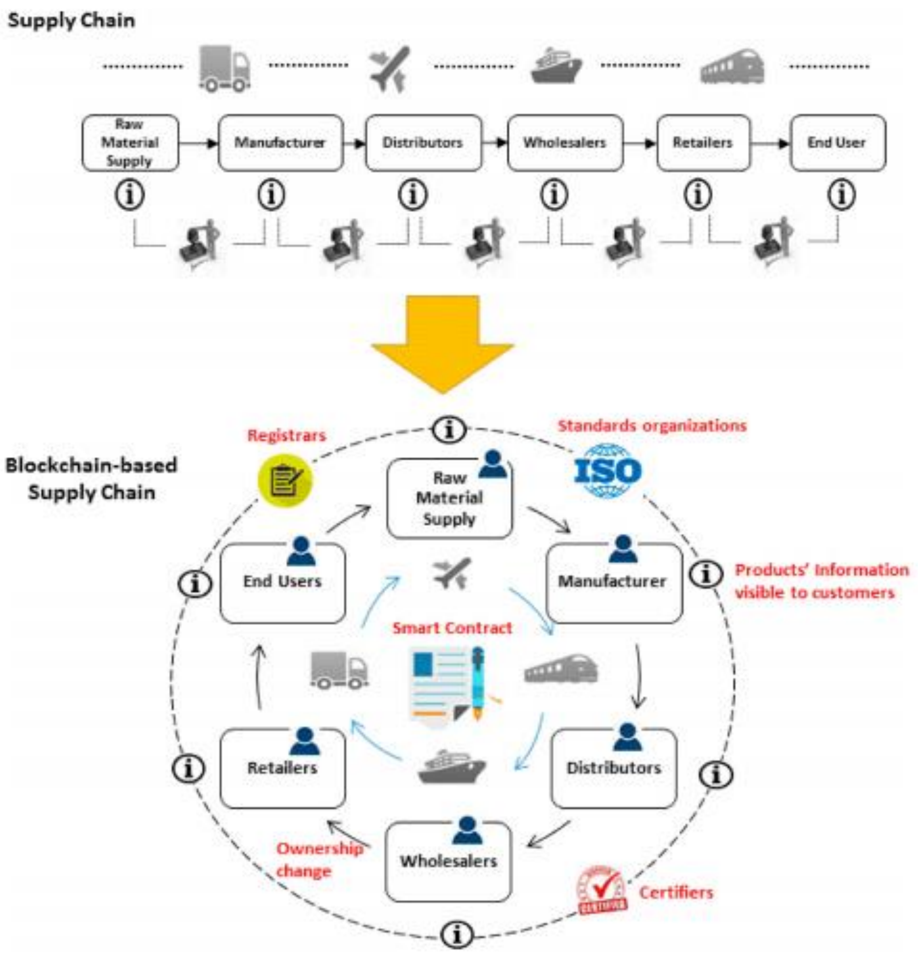
However supply chains have been identified to be opaque to consumers making it hard for them to identify the source and the path which the products moved through, studies done have shown that Blockchain could be considered in tracking food products in the supply chain (Iansiti & Karim, 2017). The idea of SCM using blockchain has been conceptualized by organizations to track incidences of food (Sarkis, Qinghua, & Kee-hung, 2011).

Walmart and Kroger embraced the technology and successfully did their cases of supply of Mexican Mangoes and Chinese Pork (Kamath, 2018). Use of blockchain reduced time for tracing source of mangoes significantly to 2.2 seconds thus enhanced transparency across organization's food supply chain.

Carrefour which is a European grocer uses blockchain to trace the origins of various food including; dairy products, fish, fruits, meat and vegetables as well as verifying their standards (Norberg, 2019).

(Kamilaris, 2019) ripe.io designed a Blockchain of Food (Ripe.io, 2017), using a food quality network that map the food's path from production to consumption.

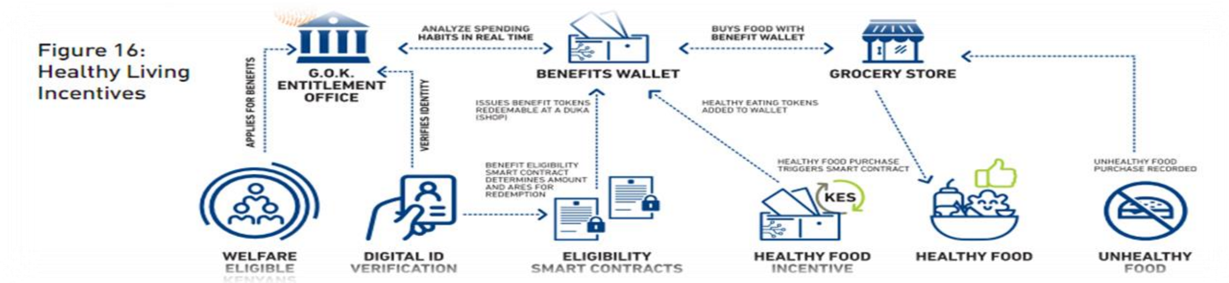
Figure 3: Supply Chain Transformation



Source: (International Journal for Research on Blockchain for sustainable supply chain Saberi et al, 2018)

Li et al. (2018) recommends use of blockchain in enhancing food traceability in supply chain while (Kim, M, & Marek, 2018) concludes by saying that transparency issues and inefficiencies in businesses and supply chain practices can be solved by use of blockchain.

Figure 4: Blockchain in Food Supply Chain



Source: (Blockchain Task Force report Kenya, July 2019)

2.7 Extended Supply Chain Transparency Framework

Blockchain transforms the traditional supply chains in facets by influencing the flow of materials and the products using identifiers and tags which virtually linked to the physical products (Abeyratne, S A, & Radmehr P., 2016).

(Panta, Prakash, & Farooquie, 2015) Reviewed the traditional supply chain transparency framework and extended it from three to six holistic dimensions inter-related categories of information comprising of;

i. ***Traceability information -*** processes and actors in a supply chain.
ii. ***Transaction Information-*** purchasing decisions of different actors in the supply chain.
iii. ***Risks information-***reports on stages –specific risks in a supply chain.
iv. ***Policy and commitment information-*** policies adopted by different actors.
v. ***Activity information-*** reports on actions and extent to which it influences the actors' behaviors.
vi. ***Effectiveness Information-*** information on interventions and effective ways of reducing societal and environmental negative outcomes in supply chain.

2.7.1 Drivers for Blockchain-based supply chain.

Table 3 : Key Drivers

Driver	Indicator	Outcome
Traceability	Production information	Increased Transparency, Security and Auditability
	Distribution information	
	Product information	
Innovation	Level of technology maturity of various actors.	High Efficiency
Risk reduction	Level of collaboration between partners	Increased consumer trust
Revenue growth	Product Market Penetration	Cost Savings
Policies and Regulations	Level of data quality and standardization	Increased Compliance

2.8 Overview of Readiness Assessment

E-readiness is the degree of preparedness of an organization to use ICT or an innovation in enhancing their quality of services. The Level of readiness is an important element in linking organization's goals to its objectives (Kashorda & Waema, 2014).

2.8.1 Readiness assessment Theoretical Background

(Clohessy, Trevor, Thomas, Reuben, & Michelle, 2018), states that diverse organizations have elements to put into consideration when assessing their level of readiness for an innovation. Implementing a new technology requires sufficient technological infrastructure that is well synergized with good governance and qualified personnel to manage and use the technology. (Clohessy, Trevor, Thomas, Reuben, & Michelle, 2018) Considers management support, commitment and technology management procedures to influence decision on use of a technology.

2.9 Readiness Assessment Theoretical Frameworks

There are many theories and frameworks that are used in technology readiness assessment such as unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003), diffusion on innovation (DOI) (Rogers, 1995), and technology, organization, and environment (TOE) framework (Tornatzky & Fleischer, 1990).

Among the list of available theories, the DOI theory and the TOE framework, are considered for readiness assessment at the organizations' level. (Rogers, 1995) on DOI theory, innovativeness is determined by leaders attitude and organization's characteristics like size, knowledge, skills and compliance to policies.

TOE framework has three factors which are considered crucial in determining organizations willingness to implement a technological innovation: technological, environmental contexts (Tornatzky & Fleischer, 1990).

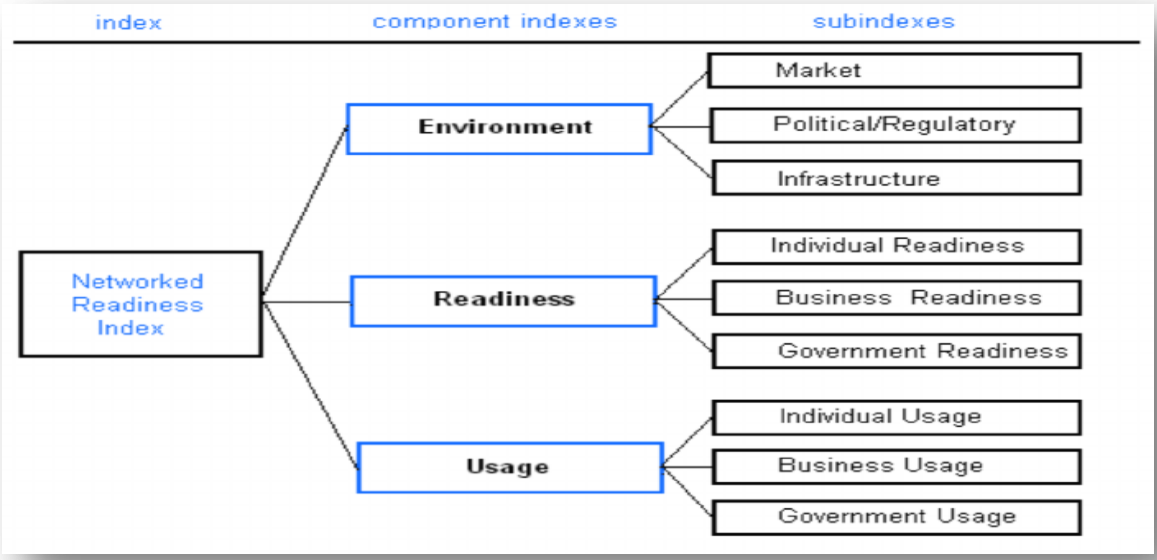
Table 4: Summary of readiness related studies and tools used

Readiness assessment	Framework Used	Analyzed constructs	Author
ICT Indicators in Higher Education: Towards an E-readiness Assessment Model	KENET readiness assessment model derived from Networked Readiness Index(NRI)	Network Access, Networked society, Networked campus, Networked learning and Institutions ICT strategy	(Kashorda & Waema, 2014)
Readiness Assessment of South African Governmental Parastatals for Big Data Analytics.	TOE Framework	Technological ,Environmental and Organizational Contexts	(Motau,2016)
Readiness assessment model for e-Learning in institutions of higher learning in Kenya: a case of University of Nairobi	(Njihia, Oketch, & Wausi, 2014) model	Demographic factors, Culture Readiness, Technological Readiness, Content readiness	(Njihia, Oketch, & Wausi, 2014)
Assessment of Blockchain Technology Readiness Level of Banking Industry: Case of Turkey	IIS Domains Theory	Strategic, Technical, Organizational	(Atasu, Ozturan, & Hasan, 2019)
Business intelligence readiness factors for higher education institution	(Nooradilla, et al., 2016) HEI Model	Technological Social Organizational	(Nooradilla, et al., 2016)
e-readiness assessment of a constitutional Office	ICT e-Readiness Model	ICT Hardware, ICT Infrastructure, People and Human Resources and Software and Information System	(Mwangi,2019)

2.9.1 Network Readiness Index

The NRI is an assessment tool being used by World Economic Forum to rank countries .The tool was derived from framework done by Center for International Development at Harvard University (Dutta, 2008). NRI assesses the readiness in four dimensions which include environment (regulatory and business); organizational readiness, usage and impact as shown in the figure 5.

Figure 5: Networked Index readiness dimensions



Source: WEF (2004)

2.9.2 KENET Assessment Framework

Kashorda & Waema,(2014) developed KENET readiness assessment tool to carry out a survey on ICT utilization in 30 universities in Kenya. The framework was adopted from the Harvard university center for international development which has five categories of assessments. Which are;

i) Access to Network (infrastructure, availability, affordability and speed of internet indicators).

ii) Networked Society (4 indicators-people, relevant content, ICT in workplace and ICT in everyday life).

iii) Networked Campus(e-campus and network environment)

iv) Networked learning (ICT in education, ICT in workforce development, ICT in research and ICT in libraries indicators).

v) Institutions' ICT Strategy (3 indicators –ICT human capacity, financing and strategy).

2.9.2 Technology-Organization –Environment (TOE) Framework

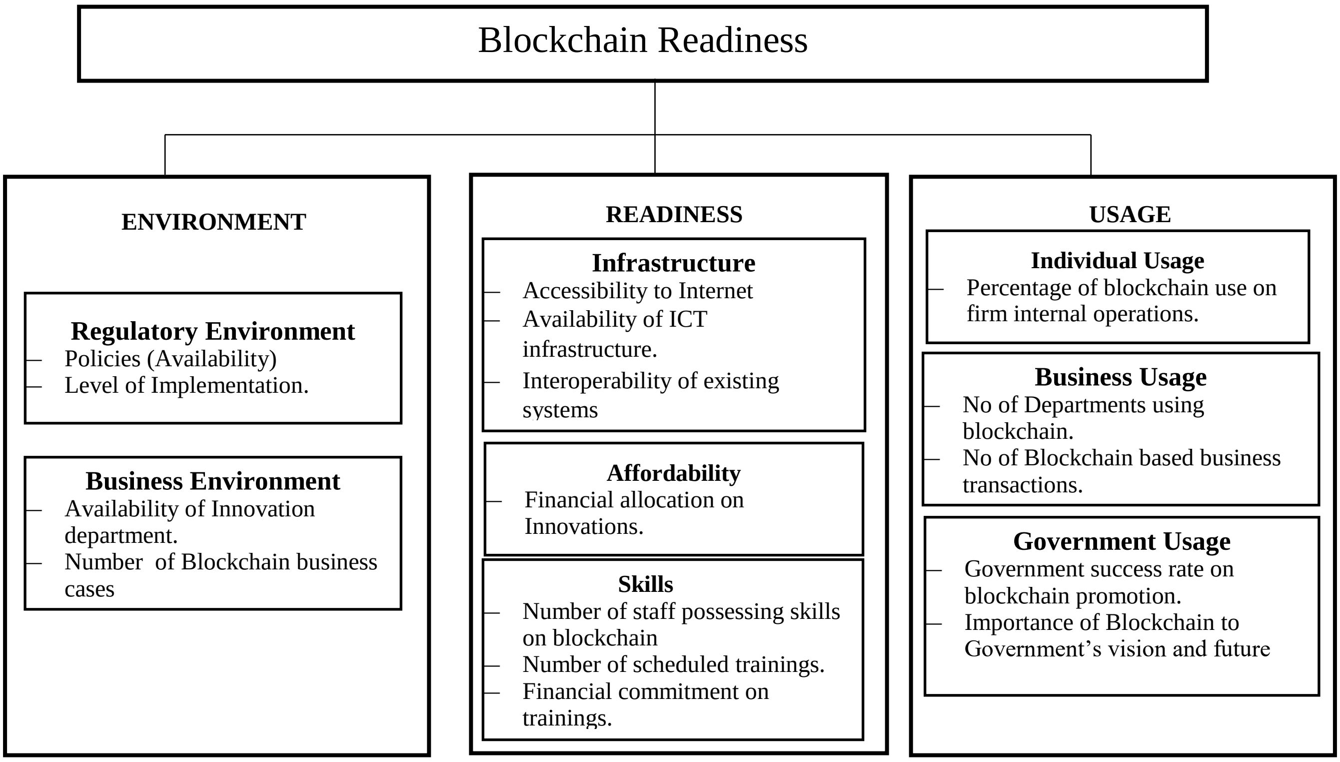
(Aboelmaged, 2014) TOE framework has been tested across various contexts to ascertain its usefulness, empirical and theoretical strength in assessing readiness and implementation of innovations.

The framework plays a role in embracing an innovation decision. It has aspects that are categorized into three, that is technology (innovation), organization (the party that uses or intends to use a technology), and environment (where innovation is applied) (Tornatzky et al., 1990).

These aspects affect level of readiness and the need of an organization to implement an innovation (Rybicka, Justyna, & Ashutosh, 2016).

2.9.3 Research Framework

From the theories analyzed, a framework was adapted from Network Readiness Index (NRI).The framework considered 3 components (Environment, Readiness, usage) with 8 indicators and 16 independent variables relevant for this study as shown below.



2.9.4 Operationalization of Conceptual Framework

Component	Indicator	Metrics
Environment	Policies & regulations Business Environment	-Availability of blockchain based policies, regulations and governance frameworks. Excellent/Poor -Availability of DLT Innovation section. -Number blockchain based innovations. High/Low
Readiness	Infrastructure Affordability Skills	-Accessibility to internet. -Availability of interoperable infrastructure and systems. Excellent/Poor -Financial commitment to blockchain and other emerging technologies. -Number of staff possessing relevant skills on blockchain. -Financial allocation on training and capacity development. Excellent/Poor
Usage	Individual Usage Business Usage Government Usage	- Percentage of individuals using DLT in the firm. -Number of departments using blockchain for business. -Number of blockchain based transactions. -Perceived government success rate on blockchain promotion. -Importance of blockchain to government's vision and future. Excellent/Poor

CHAPTER THREE: RESEARCH METHODOLOGY

The chapter highlights the methodology used including design techniques, sample population, sampling, data collection, analysis and presentation in the research.

3.1 Research Philosophy

The study adopted the pragmatic philosophy that considered use of mixed methods and procedures to complement each other since the limitation of approaches were put into consideration during the research.

3.2 Research Design

Network Readiness Index (NRI) framework was adopted in order to assess e-readiness of domestic horticulture in Kenya in the use of blockchain. This study adopted survey method because of its suitability for exploring relationships between constructs or variables in a study (Oates, 2006).

3.3 Target Population

(Ogula, 2005) defines a population as a group of institutions, persons or objects that have shared characteristics.

The target population for the study comprised of key decision makers and general users of traceability systems in Kenyan urban domestic horticulture (AFA, IBM, and ICT Authority and Consumers).

3.4 Sampling

Purposive and stratified sampling was used since the sample was made of key heterogonous industry players were knowledgeable in regard to policies, regulations, development and use of ICT innovations for dissemination of information and in the urban domestic horticulture supply chain.

3.4.1 Sample Size

The study used the Slovins (1960) formula to get the required sample size. Mugenda (2003) and Kothari (2004) stated that use of statistical formulas should aid the sample size achieve;

i. Acceptable confidence levels.
ii. Standard deviation.
iii. Confidence interval.
iv. Margin of acceptable error

$$n = \frac{N}{1 + Ne^2}$$

N is the population Size – 120 is the target population for this study.

1 is the constant factor.

E is margin of error -5 % for this study with a confidence level of 95%

n is the sample size

Hence n = 140 for this research

3.5 Data Collection

The data collection involved use of survey technique whereby online self-administered questionnaires were sent to respondents via email so as to help in collection of data relevant to the study. The study was undertaken between January and February 2020.

Table 5: Data Collection Methods

Source of Data	Type of Data	Importance of Data Collected
Surveys with ICT Workforce.	Quantitative and Qualitative	To gain an understanding of supply chain traceability system in the target organizations.
Survey CIO, Finance Team, HRM, Head of Innovations, Head of Policies and Standards.	Quantitative Data	To understand decision-process regarding innovations like blockchain technology within organizations.
Survey ICT regulators.	Quantitative data	To assess the existing policies, procedures and standards governing block chain technology.
Survey General Users	Quantitative Data	To gain understanding on level of knowledge and involvement on BCT.

3.6 Data Analysis

Data was analyzed quantitatively where numerical coding were used for measurements of opinions. The Statistical Package for Social Sciences (SPSS) was used to run descriptive statistics (frequency, mean, standard deviations and percentages), Model testing and regression analysis .Excel was also used for staging analysis and generation of radar diagram. Presentation of results was in form of tables, figures and graphs according to factors and indicators from the framework giving a visual representation of results.

Furthermore, readiness levels of factors were determined by use of e-readiness scale according to existing studies. Ouma et al (2013) used a scale of 1 to 5 to measure e – readiness level. Similarly this study used a similar four point scale:

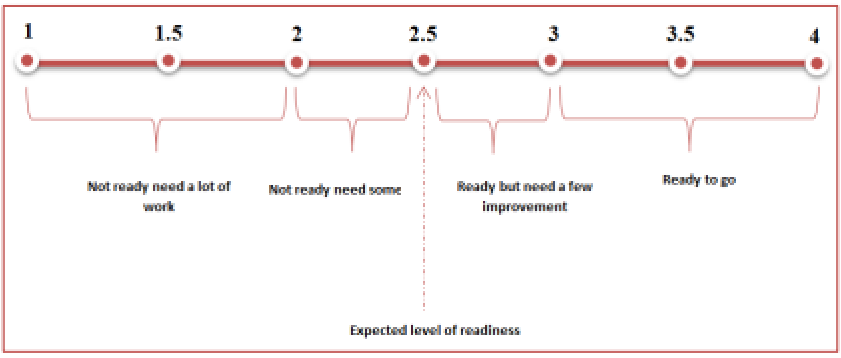


Figure 6 : Readiness measurement scale source Ouma et al (2013)

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Existing Horticultural Traceability Systems in Kenya

The study established that the system aims to introduce increased transparency and visibility of horticulture supply chain activities through electronic registration of export horticulture growers and critical supply chain processes, from farm to distribution. The system enables stakeholders to rapidly record, retrieve and share information on the farm origin of products in order to enhance traceability. The NHTS system, though very promising for uptake by the domestic sector, has however, not been implemented by value chain actors in domestic market and its awareness level is low.

4.2 Online Survey Response Rate

The population of the research comprised of users and management at the target organizations .The management were considered to be key decision makers in blockchain related matters.

The response rate for the survey was 75.71% where 106 of the 140 respondents in the target population participated. As shown in table 7.The findings presented were therefore based on results of the responses.

Category	No. of Surveys	Percentage (%)
Surveys Submitted	106	75.71%
Surveys Not Submitted	34	24.29%
Total	140	100%

Table 6: Summary of Responses

4.3 Reliability of Constructs

Before analyses of results was done, a reliability test was conducted on the constructs so as to determine whether each item fit and can relate as a group .The Cronbach's Alphas averaged results were as in Figure 7 below.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.908	.910	16

Figure 7: Reliability test

The reliability test of 16 items was satisfactory, since they were above the acceptable value of 0.6 (Sekaran, 2016).An average of items was 0.91 indicating their reliability and consistency. The items were recorded, combined and analyzed as per the research framework.

4.4 Descriptive Analysis

4.4.1 Blockchain and Users Training Levels

The findings established that 34 respondents (48.6%) had the skills whereas 36 (51.4%) had no blockchain related skills (table 7).

Blockchain Skills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	57	53.8	53.8	53.8
	Yes	49	46.2	46.2	100.0
	Total	106	100.0	100.0	

Table 7: Blockchain Skills

Further analysis indicated that among those who possess the skill, 64.2 % were up to the basic level, 21.6% intermediate and 14.2% advance level (Figure 8).

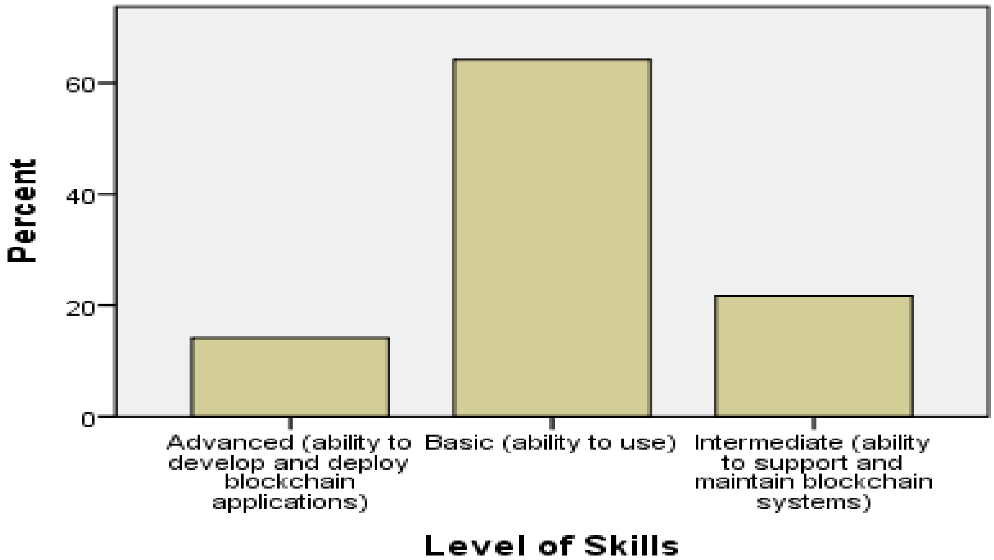


Figure 8: Level of Blockchain Skills

4.4.2 Stakeholders Perception to Blockchain Readiness

The study aimed at establishing the stakeholders' perception to Blockchain readiness. From the findings, there was an agreement that blockchain enhances service delivery in horticultural sector (Mean =1.7, Std.dev=0.8) and increases domestic produce traceability (Mean=2.1, Std.dev=0.8).Some findings however indicated uncertainty on involvement of all employees in Blockchain innovation activities (Mean =2.9, Std.dev=1.2) (table 8).

	SA	A	N	D	SD	Mean	Std Dev.
Blockchain technology enhances services delivery	54	28	24	0	0	1.7	0.8
Use of blockchain increases horticultural traceability	20	61	25	0	0	2.1	0.7

All employees are involved in blockchain innovation activities	24	16	16	49	1	2.9	1.2
Average						**2.3**	**0.9**

Table 8: Stakeholders Blockchain readiness perception

The findings imply that the users perceive the technology as an as an efficient way of retrieval, sharing and dissemination of information to actors in the industry thus improving services and increase consumers' trust.

The results correlate with studies done by (Norberg, 2019) which states that blockchain can enhance traceability of fruits produce in horticultural sector in the context of Europe.

4.4.3 Organizational Blockchain Regulatory Environment

The research sought to establish the existence of blockchain regulatory measures in the target organizations and the level of users' awareness on the frameworks. It was however not clear whether there are well formulated policies and regulations on blockchain (Mean =3.2, Std.dev=1.0) and as to whether the employees in the organizations were well conversant with the policies (Mean=3.4, Std.dev=0.8) (table 9).

	SA	A	N	D	SD	Mean	Std Dev
The organization has well formulated policies, regulations and frameworks governing blockchain.	8	17	19	61	1	3.2	1.0
Employees are well conversant with the existing policies and guidelines on blockchain.	7	10	20	69	0	3.4	0.9
Average						**3.3**	**1.0**

Table 9: Blockchain regulatory environment

The finding therefore implies that, organizations are at the initial stages of implementing the technology.

4.4.4 Organizational Blockchain Business Environment

The findings indicated that the organizations had existing sections for innovations (Mean 2.2, Std.dev=0.8) .However there was a disagreement on existence of blockchain based innovations and business cases (Mean=3.0, Std.dev=1.0), there was an agreement that the organizations have conducted an analysis on their business processes (mean=1.9, Std.dev=0.9) since the environment was flexible for the technology (Mean=2.1, Std.dev=0.6) (table 10).

	SA	**A**	**N**	**D**	**SD**	**Mean**	**Std Dev.**
The organization has got an existing section for	16	70	8	11	1	2.2	0.8

innovations.							
Our organization has carried out analysis on current business processes	36	49	9	12	0	1.9	0.9
Our existing business processes are flexible to accommodate blockchain technology.	8	69	28	1	0	2.1	0.6
There exists blockchain based innovations and business cases in the organization.	8	33	16	48	1	3.0	1.0
Average						**2.3**	**0.8**

Table 10: Blockchain business environment

4.4.5 Blockchain Infrastructural Readiness

The study aimed at establishing the existence of the internet and ability of the infrastructure to support blockchain systems and applications. The findings showed a unanimous agreement that the existing internet is accessible and reliable (Mean=1.9, Std.dev=1.2).However, there was uncertainty on the interoperability of the existing infrastructure and systems with blockchain based systems (Mean=2.8, Std.dev=0.6) (table 11).

	SA	A	N	D	SD	Mean	Std Dev
Existing internet is accessible.	57	21	8	19	1	1.9	1.2
Infrastructure and systems in place are highly interoperable with blockchain systems.	8	60	36	1	1	2.8	0.6
Average						**2.4**	**0.9**

Table 11: Infrastructure readiness

4.4.6 Blockchain Affordability

An analysis of findings indicated that actors had an ability to commit finances on the technology (Mean=2.5, Std.dev=1.1).On the other hand there was a disagreement on spending on research and development of the technology at the organizational level (Mean=3.5, Std.dev=1.0) (table 12).

	SA	A	N	D	SD	Mean	Std Dev
The organization is financially able to invest on distributed ledger technologies especially blockchain.	28	17	40	21	0	2.5	1.1
The organization has been spending on research and development on blockchain technology.	8	9	24	53	12	3.5	1.0
Average						**2.9**	**1.0**

Table 12: Blockchain Affordability

4.4.7 Blockchain Skills Readiness

Assessment and analysis established that users as well as consumers had inadequate skills on the technology (mean=3.0, Std.dev=0.8).There was also an agreement that existing ICT workforce had no requisite skills to develop applications on blockchain platforms (Mean=3.4, Std.dev=1.1), and that there were no adequate funding on trainings and capacity development (Mean=3.0, Std.dev=1.1) (table 13).

	SA	A	N	D	SD	Mean	Std Dev
Users have necessary skills and competence on blockchain technology.	20	21	25	32	8	3.0	0.8
The ICT workforce can develop, support and develop blockchain applications.	8	8	21	68	1	3.4	1.2
There is adequate budget commitments on trainings and capacity development.	16	15	32	33	10	3.0	1.1
Employees have attended trainings and sensitizations of block chain technology.	8	28	34	35	1	2.9	0.7
Average						**3.1**	**1.0**

Table 13: Skills readiness

4.4.8 Level of Blockchain Usage by Horticultural Stakeholders

The research purposed to find out the level of usage of blockchain by stakeholders for individual, business and transaction of government horticultural services. The findings indicated low usage in all the three cases; individual usage (Mean=3.4, Std.dev=1.1), business usage (Mean=3.4, Std.dev=1.3) and Government usage (Mean=2.8, Std.dev=0.6) as shown in table 14, table 15 and table 16 respectively.

	N	Mean	Std. Deviation
Individual Usage	106	3.4143	1.14832
Valid N (listwise)	106		

Table 14: Individual Usage of Blockchain

	N	Mean	Std. Deviation
Individual Usage	106	3.3585	1.32513
Valid N (listwise)	106		

Table 15: Business Usage of Blockchain

	N	Mean	Std. Deviation
Government Usage	70	2.7857	0.60069
Valid N (listwise)	70		

Table 16: Government Usage of Blockchain

The study results imply that the level of uptake of blockchain as well as readiness level is still low among the actors in the horticultural sector in Urban Kenya.

4.4.9 Stakeholders Perception on Future Value of Blockchain Technology.

The research intended to establish the perception of horticultural actors on future worth of blockchain technology. The findings showed that 58 (82.9%) had a unanimous agreement that the future value of the technology in the industry is significantly high (table 16).

Future Value

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	53	50.0	50.0	50.0
	2.00	37	34.9	34.9	84.9
	3.00	8	7.5	7.5	92.5
	5.00	8	7.5	7.5	100.0
	Total	106	100.0	100.0	

Table 17: Future Value of Blockchain

4.5 Regression Results and Model fitting

An analysis was done on predictors to determine how they affect blockchain readiness. The predictors tested in this study were; Business Usage, Regulatory Environment, Affordability, Skills, Infrastructure, Business Environment and Individual usage while the dependent construct is blockchain readiness. The results indicated an R square value of 0.968 implying that the predictors influences the level of readiness to 96.8% (table 17) .The findings also indicated an R^2 of 0.936 to imply that when other factors are kept constant the predictors contributes to the readiness level of blockchain to 93.6%.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.968[a]	.936	.928	.25681

a. Predictors: (Constant), Government Usage, Skills, Individual Usage, Infrastructure, Business Usage, Business Environment, Regulatory Environment, Affordability

Table 18: Model Analysis

Further, tests results indicated that the model was a good fit for data (table 18).The table showed that the independent constructs significantly predict the dependent construct $F(8,61,p<0.0005)$.The p value of the model was 0.000 which satisfied the rule $p<0.0005$.

ANOVA[a]

Model	Sum of Squares	Df	Mean Square	F	Sig.

1	Regression	59.295	8	7.412	112.383	.000[b]
	Residual	4.023	61	.066		
	Total	63.318	69			

a. Dependent Variable: Blockchain Readiness
b. Predictors: (Constant), Government Usage, Skills, Individual Usage, Infrastructure, Business Usage, Business Environment, Regulatory Environment, Affordability

Table 19: Regression Results

4.6 Staging Analysis

In order to establish the readiness level of blockchain in the target organizations and consumers, Network readiness was used to map each category of the eight indicators into one of the four levels. Whereby, stage 1 indicates unprepared and stage 4 prepared.

The results indicated that in average, the stakeholders were above stage 2.0 in five of the indicators, below stage 2.0 in one indicator which is individual usage and above stage 3.0 in affordability indicator (figure 9).

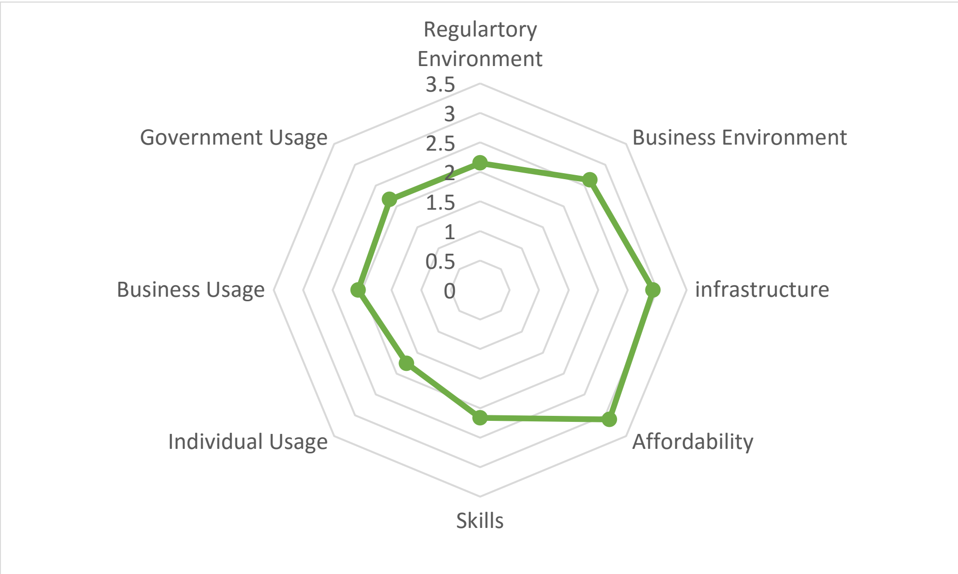


Figure 9:Average staging results

Further analysis on each category of actors (figure 10) indicated that the private organizations were at higher stage of readiness in most of the indicators followed by the government actors, whereas the consumers were at unprepared stage (below 2.0) in most of the eight indicators.

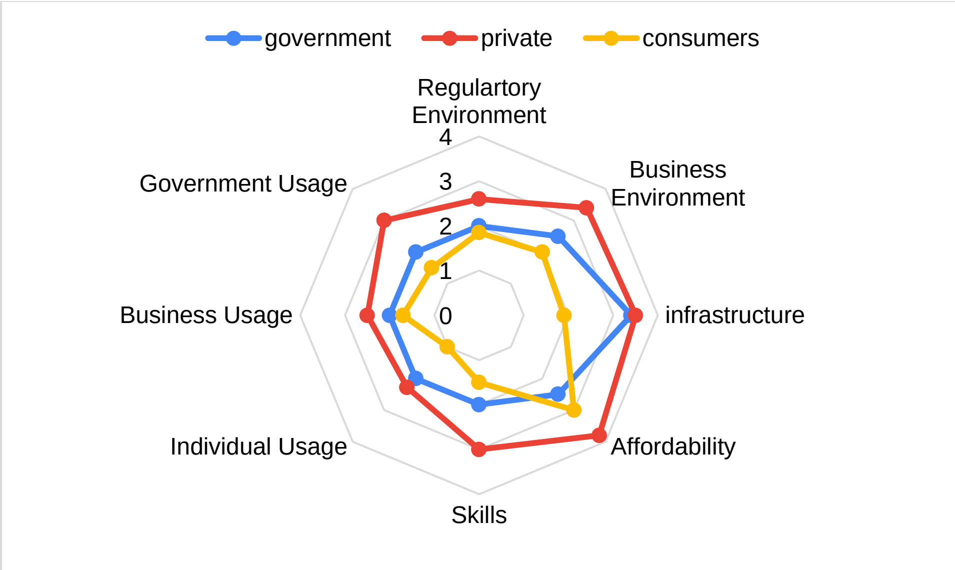


Figure 10: Individual staging results

The results suggest that the regulations and policies on blockchain is still a major challenge and that the usage in domestic horticultural industry is still low.

4.7 Discussion of Key Findings

4.7.1 Current Level of Blockchain Readiness

A staging analysis of eight factors of readiness indicated that five factors (regulatory environment, skills, business usage, individual usage and government usage) were below stage 2.5 of likert scale hence the level of readiness of BCT in the horticultural sector was found to be low. However, the study established that the future value of blockchain was perceived to be high (90%).

4.7.2 Analysis of Issues Identified

The study identified that there is need to improve levels of readiness for blockchain usage in horticultural industry

4.7.2.1 Regulatory Environment

The study shows that there exist no policies and regulations to guide the usage of blockchain among the actors in the horticultural sector. The gap has been persistent and relates with (ICT4Ag 2017) findings which highlight that there has been lack of common agreement on policies and regulations between policy makers and technical experts on blockchain.

4.7.2.2 Infrastructure

The study found out that most of the organizations had an infrastructure that was considered to be of low interoperability with blockchain. In the context of horticulture this finding relates with a study by (Zhao,et al.2019), who notes that there is need to dedicate efforts on infrastructure since the technology require computing environment of high levels.

4.7.2.3 Blockchain Skills

The study established that skills the skills in the sector were inadequate which correlates with the studies by (Zhao, et al.2019) that there is low awareness and skills on BCT attributed to inadequate training platforms (ICT4Ag 2017). Maru, et al (2018) found that there is still a gap in terms of digital skills and competence for access to blockchain technology.

4.7.2.4 Blockchain Usage

The usage of the technology by actors in respect to business, individual and government transactions was noted be low. The horticulture sector needs to establish initiatives that will enhance the championship for and the usage of the technology among the actors.

4.7.3 Blockchain Implementation Strategy

The blockchain implementation roadmap developed identified the skills, regulations, infrastructure and usage as key issues within domestic horticulture sector in Kenya. It outlines initiatives, outcomes, resources and responsibility towards improved acceptance of the technology. The blockchain and emerging technologies taskforce report (Ndemo, et al., 2019) established use cases towards use of the technology which need to be embraced. The actors need to tailor the use cases and align with the proposed roadmap for implementation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The chapter summarizes the findings based on research objectives and framework. Conclusions are drawn and recommendations for future studies given.

5.1 Summary of Findings

Objective 1: Review existing traceability technologies in horticultural food supply chain.

From literature review and survey conducted, the existing traceability technologies in Kenya are web-based .The system developed from the technology is in Pilot stage, focuses on export horticultural produce and has not been commercialized. Awareness among farmers on the system was established to be low.

Objective 2: Assess stakeholders' level of readiness towards use of blockchain for supply chain traceability using an adopted Framework.

Through analysis of data collected, it was established that the level of blockchain readiness in Kenya's horticultural sector is low. This is attributed to lack of policies and regulatory frameworks, inadequate skills; lack of commitment and low investment on infrastructure development.

Objective 3: Develop a roadmap which acts as baseline tool for implementation of blockchain in domestic horticulture supply chain.

A blockchain implementation roadmap was developed based on the readiness issues identified in the horticultural sector. The plan aims to act as a baseline tool for blockchain in Kenya. It is comprises of initiatives, resources, timelines and responsibilities of actors.

5.2 Implications for Practice

The study identified key blockchain issues in the Kenyan horticultural sector which need to be addressed in readiness for traceability.

Managers in the organizations have to expand capabilities and invest on infrastructure so as to enable blockchain-based solutions to integrate with other IT systems. Moreover, actors should partner in formulation of policies and standards so to improve attractiveness of blockchain ecosystem (ICT4Ag 2017).

Organizations should develop platforms for training, invest on skills development so to bridge the skills gap and increase domain knowledge to develop blockchain based solutions which relates to (Ndemo, et al., 2019).

5.3 Conclusion

The study outlined key readiness factors that constitute blockchain ecosystem. For actors to move high acceptance level, they should effectively support and champion for enhanced infrastructure, policies and adequate skills. The study concludes that the implementation of proposed roadmap and initiatives is fundamental in Kenyan Horticultural sector.

5.4 Limitations of Study

The study was conducted on horticultural sector specifically in the urban setup hence may not adequately cover the entire supply chain. It was also biased towards locally consumed products in Kenya.

5.5 Recommendations for Future Studies

There is need for validation of proposed roadmap and a test of its outcome on level of blockchain readiness .Further, research has to be done to assess the impact of blockchain on horticultural supply chain in Kenya.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

The study is meant academic purposes only .The information collected will be kept confidential. Please answer the questions honestly and precisely.

SECTION A: DEMOGRAPHIC INFORMATION

1. What is the name of your department……………………………………..
2. What is your designation…………………………………………………..
3. How long have you been in this department……………………………...

    Less than 1yr…..... [ ]
    1-5yrs…………. [ ]
    6-10yrs………... [ ]
    11-20yrs……….. [ ]
    20-30yrs……….. [ ]

4. What role do you play in regard to innovations and emerging technologies?

    Decision Maker [ ]
    General User [ ]

5.
    a) What supply chain traceability systems/initiatives are currently used by your Organization?

    ………………………………………………………………………………
    ………………………………………………………………………………
    ………………………………………………………………………………

    b) What challenges do you face with the current traceability systems/initiates?

    ………………………………………………………………………………
    ………………………………………………………………………………
    ………………………………………………………………………………

6.
    a) Do you have any blockchain related skills?

    Yes [ ]   No [ ]

    b) If yes what level of skills do you possess?

    Basic [ ] (ability to use)
    Intermediate [ ] (ability to support and maintain blockchain systems)
    Advanced [ ] (ability to develop and deploy blockchain applications)

SECTION B: PERCEPTION OF READINESS ASSESSMENT

To what extent do you agree on the statements below on readiness assessment on blockchain technology? On a scale of 1-5 where ;(1-strongly agree 2-agree 3-moderate 4 disagree 5-strongly disagree)

No	QUESTION	1	2	3	4	5
1	Blockchain technology enhances service delivery.					
2	Use of block chain increases supply chain traceability, trust and transparency					
4	All employees are involved in innovation activities in the organization.					

SECTION C: ENVIRONMENT

How would you rate your work environment based on the metrics shown below? (1-strongly agree 2-agree 3-moderate 4 disagree 5-strongly disagree).

Regulatory Environment						
No	QUESTION	1	2	3	4	5
1	The organization has well formulated policies, regulations and frameworks governing blockchain.					
2	Employees are well conversant with the existing policies and guidelines on blockchain.					
3	The organization has adequate number of procedures and effective measures of enforcing and implementing contracts.					
Business Environment						
4	The organization has got an existing section for innovations.					
5	Our organization has carried out analysis on current business processes					
6	Our existing business processes are flexible to accommodate blockchain technology.					
7	There exists blockchain based innovations and business cases in the organization.					
8	The leadership is committed to use of Blockchain and other distributed ledger technologies.					

SECTION D: READINESS

Kindly rate the organization readiness by assessing the following considerations

(1-strongly agree 2-agree 3-moderate 4 disagree 5-strongly disagree).

Infrastructure						
No	QUESTION	1	2	3	4	5
1	Existing internet is accessible and can support blockchain applications.					
2	Infrastructure and systems in place are highly interoperable with blockchain systems.					
Affordability						
3	The organization is financially committed to emerging technologies especially blockchain technology.					
4	The organization has been spending on research and					

	development on blockchain technology.					
Skills						
5	Employees have necessary skills and competence on blockchain technology.					
6	The ICT workforce can develop, support and develop blockchain applications.					
7	There is an adequate budget commitment on trainings and capacity development.					
8	Employees have attended trainings and sensitizations of block chain technology.					

SECTION E: USAGE

To what extent do you agree with the following statements on blockchain usage? (1-strongly agree 2-agree 3-moderate 4 disagree 5-strongly disagree).

Individual Usage						
No	QUESTION	1	2	3	4	5
1	We use blockchain for firms' internal operations.					
Business Usage						
2	Most departments use blockchain to carry out business activities.					
3	Most of the transactions in the organization are block chain based.					
Government Usage						
4	The government has succeeded highly on blockchain sensitization.					
5	My organization has participated in government sponsored blockchain workshops.					
6	Future value of blockchain to government and organizations is high					

SECTION F: BLOCKCHAIN READINESS

Blockchain						
No	Question	**1**	**2**	**3**	**4**	**5**
1	Given the necessary resources, knowledge and opportunity to use blockchain, our organization is ready for it.					
2	Our organization has begun to focus on blockchain opportunities.					

SECTION G: STRATEGIES ON BLOCKCHAIN FOR TRACEABILITY

1. How would you rate the current blockchain readiness level in your organization?(Tick one option)
   a) Excellent
   b) Good
   c) Fair(Need review)

d) Bad (Non-Existent)

2. What skills do you consider to keep up for future success of blockchain and service provision?

   ----
3. What strategies do you consider necessary for blockchain implementation success?

"Thank you for your time and positive responses to this study"

APPENDIX 2: BLOCKCHAIN IMPLEMENTATION ROADMAP

A ROADMAP FOR IMPLEMENTATION OF THE BLOCKCHAIN TECHNOLOGY IN THE HORTICULTURE SECTOR IN KENYA

Towards Adoption of Blockchain In Food Industry

EXECUTIVE SUMMARY

Food falsification and other safety related concerns have accelerated need for consumers' welfare. A part from a health concerns, it affects economic and business relations among stakeholders. Traceability systems are vital in enhancing accountability in horticultural supply chain. Several traceability technologies have been implemented globally BCT as the newest technology.

Blockchain implementation roadmap is developed so as to foster leveraging of the technology in the Kenyan horticultural sector. Kenya is known to be among the top horticultural producers in Africa and globally. In respect to this, there is need to embrace the technology through partnership by government, private sector, producers and consumers. This will improve traceability, minimize food frauds and increase safety concerns and contribute to realization of the Kenyan Government Big 4 Agenda on sustainable food security.

The roadmap provides a clear understanding to the actors (policy makers, innovators, researchers, regulators and consumers) on issues identified during a readiness assessment that was done. It also helps in providing a clear sense of direction and initiatives to undertake so as to align the implementation of the technology to organizations' strategies and priorities.

For the actors to capitalize and realize the full benefits of the blockchain technology on horticultural sector there is need to address the following fundamental issues;

i) Formulate appropriate and effective policies and regulations on the technology.
ii) Develop skills, competences and capabilities that drive the use of the technology.
iii) Invest on infrastructure that is ideal and can support blockchain.
iv) Create awareness and establish collaboration among actors.

The technology is new and disruptive thus it requires regulatory frameworks that are appropriate.

Lack of awareness and skills will slow down the realization of the potentials of the technology.it therefore requires an investment on developing skills that drive innovation on blockchain in the sector.

Absence of ideal infrastructure, platforms and computing environment hinders the deployment and usage of blockchain.

Seizing the opportunities that blockchain has require an explicit collaboration among actors. This Roadmap provides a baseline and highlights some key steps towards collective efforts in addressing issues and embracing blockchain towards endowed future value.

1. INTRODUCTION

Blockchain technology has attracted a lot of considerations globally as a potential solution to increasing efficiency and reducing existing problems in most industries.

The technology uses the concept of a distributed ledger which comprise of immutable, digital data known as blocks. Each block is then "chained "into networks using cryptographic signatures.

A distributed ledger (DLT) is a form of database that can record data, share, replicate among members of a network in trusted and secure manner (ITU, 2018).

There exist numerous issues on traceability, transparency and efficiency in agri-food supply chains putting actors to difficulties. The complexity of transactions and a large number of intermediaries pose a risk on safety and trust on products. Strengthening the networks among actors can solve the challenge (FAO 2017).

Companies in developed nations like Italy have partnered with IBM to solve traceability and transparency of pesto and sauce production from cultivation, harvesting, transportation. Details are traceable and consumers can be able to verify product records.

IBM's Food Trust developed an IBM Blockchain for Walmart to track processed mangoes along its supply chain from retail shelf in seconds (Wass 2017b).

Currently, Kenyan horticultural sector is in pilot of a National Horticulture Traceability System (HTS) which is a web-based system. The system is yet to be commercialized and its awareness among farmers is considerably low.

Kenyan horticultural sector is not different in terms of challenges encountered and that blockchain has a potential to improve efficiency, increase traceability and trust throughout and among the sector players. This will eventually contribute to sustainable horticulture and consumption of safe produce.

There is also need for the use cases proposed by blockchain and emerging technologies taskforce (Ndemo, et al., 2019) to be actualized. This roadmap is informed by the report and gaps that were identified during a readiness assessment study that was conducted among stakeholders between January and February 2020.

2. REGULATIONS, STANDARDS AND POLICIES

Blockchain policy and regulatory frameworks in the context of Kenyan horticulture is at its early stages. Standards also are undeveloped hence need to invest on formulation and sensitization so as to provide an ideal ecosystem for the technology. This will promote mutual consensus among developers, policy makers, innovators, consumers and regulators. Further it will minimize risks associated to usage, security of platforms and privacy.

(Ndemo, et al., 2019), emphasizes that the Government role is vital and essential in formulation of policies that balances innovation and regulations .It is also a key actor in protecting users from impacts of disruptive technologies.

3. INFRASTRUCTURE AND TECHNOLOGIES

Blockchain implementations are hampered by poor infrastructures which are not interoperable with new technologies .Capability analysis of existing infrastructures should be conducted .Investment on compatible with high computing capacity will enhance maximum efficacy in adoption of blockchain.

4. HUMAN RESOURCES: SKILLS AND INNOVATION

Inadequate skills to develop and innovate on blockchain are a key concern that needs to be addressed through multi-sectorial partnerships. Support, focus and investment on skills and capacity development will significantly improve the level of readiness for blockchain specifically in Kenyan horticultural sector.

Research and innovations in Organizations need to be adequately financed and be made a culture through establishment of championship initiatives and incentives for the technology.

5. IMPLEMENTATION PLAN

Issues Identified	Initiatives	Outcomes	Projection(Time and Resources)			Responsibility
			Indicator above stage 3.0	**Indicator between stages 2-3.**	**Indicator below stage 2**	
Lack of Skills on Blockchain among the users and ICT workforce.	Establish appropriate mechanisms for training and skill enhancement	Enhanced skills on use, support and development of blockchain applications.	-Workshops, Seminars, Personnel and adequate funding for trainings. -Timeline in 1 year	-Workshops, Seminars, Personnel and adequate funding for trainings. -Timeline in 2 years	Workshops, Seminars, Personnel and adequate funding for trainings. Timeline in 3 years	Both Private and Government Actors.
Lack of Blockchain regulations, policies and standards.	Formulate frameworks, standards and policies on blockchain use in Kenya.	Appropriate use and implementation of Blockchain systems.	-investment on policy formulation -Immediately	- investment on policy formulation -In 1 year	- investment on policy formulation -Between 1-2 years	Partnership ICTA, AFA, IBM and Consumers.
Low involvement of users on Innovations, research and development on Distributed Ledger technologies	Create and implement a mechanism of involving and motivating creativity, development and innovation among the employees and users	Increased motivation for research and Innovation.	-Invest on innovations research and development. -Immediately	-Invest on innovations research and development. -Between 6months-1Year	- Invest on innovations research and development. -In 2 years	CIOs
Low systems and infrastructural interoperability.	Conduct an assessment on infrastructure flexibility, scalability and systems interoperability.	Increased awareness on systems and infrastructural capabilities.	-Conduct business systems capability analysis -immediately	-Conduct business systems capability analysis -immediately	-Conduct business systems capability analysis -immediately	CIOs
Low championship for blockchain among government actors.	Top Leadership in Kenyan horticultural sector to champion for blockchain use.	Adequate support and funding on blockchain initiatives.	-Awareness, sensitization and Workshops for Leadership. -Immediately.	-Awareness, sensitization and Workshops for Leadership. -The in 1 year.	-Awareness, sensitization and Workshops for Leadership. -The in 2 years.	Top Management and CEOs