ATILIM UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION
BUSINESS ADMINISTRATION DOCTORAL PROGRAMME

BLOCKCHAIN-BASED FRAMEWORK FOR IMPLEMENTING SUPPLY CHAIN TRACEABILITY SYSTEMS: A COST-EFFECTIVE APPROACH

Dissertation

Abdikarim Mohaidin AHMED

Ankara-2023

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Dissertation

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Thesis Advisor

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Ankara-2023

ACCEPTANCE AND APPROVAL

This is to certify that this thesis titled “Blockchaın-based framework for ımplementıng supply chaın traceabılıty systems: a cost-effectıve approach” and prepared by Abdikarim Mohaidin Ahmed meets with the committee’s approval unanimously/by a majority vote as Dissertation in the field of business adminstration following the successful defense conducted on 11/07/2023

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ETHICAL STATEMENT

I accept and acknowledge that I have prepared this thesis study, prepared in line with the Thesis Writing Guidelines of Atılım University Graduate School of Social Sciences;

- within the framework of academic and ethical rules;
- presented the information, documents, evaluations, and results in a way that meets the rules of scientific ethics and morality,
- I have referenced each work from which I have benefited while preparing my thesis, and that
- I hereby present a unique study.

I hereby also understand that I shall accept any loss of rights against my behalf in cases otherwise.

ÖZ

Abdikarim Mohaidin Ahmed, Tedarik Zinciri İzlenebilirlik Sistemlerini Uygulamak İçin Blok Zincir Tabanli Çerçeve: Maliyet Etkin Bir Yaklaşim, Doktora Tezi, Ankara, 2023.

Bu çalışma, özellikle gıda sektöründe yaşanan çeşitli olaylarla birlikte, tedarik zinciri boyunca izlenebilirliğin daha da önemli hale geldiği bir zamanda gerçekleştirilmiştir. Öncelikle, çalışma küresel pazarın, köken ülkelerinden başka kıtalara kadar malların seyahat etmesini kolaylaştırarak gıda ürünlerinin tüketimini yaygınlaştırdığını belirtmektedir. Ancak, bu durum aynı zamanda bu ürünlerin kalite ve güvenliğiyle ilgili endişelerin artmasına neden olmuştur. Bu da, tedarik zinciri boyunca izlenebilirliğin önemini artırmıştır.

Somali'deki yerel tüketim büyük ölçüde ithal ürünlere bağımlıdır ve bu ürünlerle ilgili güvenlik ve kalite sorunlarına ilişkin endişelerin belirtildiği çalışmaktadır. Bu noktada, 2020 yılında 4.2 milyar dolarlık ithalat gerçekleştirilmiş ve bu bağlamda Somali Standartlar Bürosu (SBS) tarafından Standartlar ve Kalite Kontrol Yasası Kanun No. 27'ye uygun olarak kurulmuştur. SBS, beklenen güvenlik ve kalite sorunlarını ele almakla görevlidir.

Çalışma, Somali'deki tedarik zinciri izlenebilirliği üzerinde herhangi bir düzenleme veya yönergenin bulunmadığını belirtmektedir. Ancak araştırmanın sonuçları, Somali'deki KOBİ'lerin blok zinciri tabanlı çözümlerle merkezi olmayan ve maliyet etkin bir tedarik zinciri izlenebilirlik sisteminin uygulanmasına olumlu bir bakış açısına sahip olduğunu ortaya koymuştur. Ayrıca, araştırma Somali Standartlar Bürosu'nun blok zinciri tabanlı bir izlenebilirlik çerçevesini destekleyeceğini ve finanse edeceğini belirtmektedir.

Sonuç olarak, bu çalışma, Somalili tedarik zinciri paydaşlarının, blok zinciri tabanlı bir izlenebilirlik sistemi dağıtımını destekleyen bir çerçeve sunarak, tedarik zinciriyle ilgili bilgilerin iletişimini kolaylaştırmaları gerektiğine vurgu yapmaktadır. Ayrıca, politika yapıcıların bu tür sistemlere yönelik yasalar ve kurallar çıkararak izlenebilirlik altyapısını mümkün kılmada da rol oynadığı belirtilmektedir.

Anahtar Kelimeler: Blok Zinciri, İzlenebilirlik Sistemi, Tedarik Zinciri, Şeffaflık, Ürün Güvenliği.

ABSTRACT

The global nature of today's market has made it easier for goods to travel across continents. Concerns over the quality and safety of these items are rapidly developing. Traceability throughout supply chains has become somewhat more important in recent years, notably in the food sector in the wake of multiple events involving food safety. In the context of the western world, the enactment of a traceability system that canprovide precisedatahas resulted in a rise in theoverall level of product security, particularly with regard to foods and other commodities.

Domestic consumption in Somalia is mostly reliant on imported goods. In 2020, Somalia spent $4.2 billion on imported goods. In accordance withthe Standards and Quality Control ActLaw No. 27, the Somali Bureau of Standards (SBS) was founded in 2020 to handle the anticipated safety and quality problems with the imported items. This study examined the current supply chain traceability systems, the governing regulations and rules that mandates supply chain traceability, and the factors that affect the implementation of traceability framework which is blockchain-basedto simplify the sharing of information among stakeholders and guarantee transparency within the supply chain.

The data provided by major stakeholders has been collected, analyzed, and interpreted in a structured manner. To collect a data of both a quantitative and qualitative nature, a mixed-mode technique has been employed.Face-to-face interviews and written questionnaires based on a five-point Likert scale served as the primary approachfor collecting datain this study. The findings of the study confirmed the absence of any regulations or guidelines governing the traceability of the supply chain in Somalia.SMEs in Somalia hold a positive outlook towards the implementation of a decentralized and cost-effective supply chain traceability systemusing blockchain-based solutions. The research found that the Somali Bureau of Standards would endorse and fund for a blockchain-based traceability framework.

The study says that policymakers also have a part to play in making traceability infrastructure possible by passing the laws and rules that force companies to use such systems. The research presented a framework that supports the deployment of a blockchain-based system of traceability. In this system, all supply chain parties including importers, the bureau, and consumers would submit essential data to facilitate the communication of supply chain-related information.

Keywords: Blockchain, Traceability System, Supply Chain, Transparency, Product Safety.

This work is dedicated to my beloved family.

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INTRODUCTION

Introductıon

Commodities travel to the edges of the world whereby producers and consumers live on different continents. However, persistent apprehensions prevail regarding the safety as well as the quality of these commodities. Food crises such as Bovine Spongiform Encephalopathy (BSE), commonly known as mad cow disease, and chicken feed Dioxin have caused credibility concerns in the food industry. In addition to that, the inclusion of Genetically Modified (GM) crops in food and the occurrence of outbreaks such as Escherichia coli, campylobacter, and salmonella have significantly amplified the concerns surrounding the safety and quality of food products(Aung and Chang 2014). Hence, traceability of the supply chain has gained relative importance and specifically within the realm of the food sector after numerous food safety incidents(Aung and Chang 2014).

According to Pant, Prakash, and Farooquie (2015), the ability to access detailed information about various aspects of the supply chain, including processes, inventory, retailers, or wholesalers, defines the concept of traceability in the supply chain. As per the argument of LĂDARU (2011), there are two distinct categories of traceability systems that can be established to track the product flow within various stages of the supply chain. These two critical systems are supply chain traceability and product traceability. To improve the safety of foods and other commodities, a system of traceability that can provide precise information has been introduced in the context of the western world.

For instance, European Commission developed an all-encompassing strategy towards ensuring food safety policy that dictated mandatory traceability of agri-food products (Banterle and Stranieri 2008). Located in the horn of Africa, Somalia's domestic consumption is mainly dependent on imported commodities from outside the country. In 2020, Somalia imported commodities costing $4.2B. This has made Somalia the 140th largest importer in the entire world. In the last five years, the imports of the country have changed by $1.98B from $2.21B in 2015 to $4.2B in 2020.

The main imported products to Somalia are foods, construction materials, fuel, medicine, electronics, and manufactured goods. The main sources of trade are India,

Turkey, Pakistan, China, Egypt, Oman, and United Arab Emirates (OEC 2020). The government of Somalia is concerned about the safety and operational efficiency of imported goods for the benefit of the population, property, animals, and the environment. To ensure the safety and well-being of the populace, the Somali Bureau of Standards (SoBS) was founded in 2020 in accordance with Law No. 27, known as the Standards and Quality Control Act. This regulatory body has been vested with the power to oversee product quality and protect consumer safety.

The efficient adoption and seamless implementation of traceability systems are widely recognized as a robust and long-lasting solution to address concerns regarding the safety of supply chains.(Sun and Wang 2019). However, there is no doubt that traceability systems will have cost implications while it is not an activity that creates first-hand value for consumers(Dessureault 2007). With the trajectory of advances in information and communication technology, the world witnessed a rapid change in the process of collecting, appending, monitoring, disseminating, and disclosing information related to the global value chain(Gardner et al. 2019).

Blockchain, a recently emerged technology, is experiencing growing popularity for its application in diverse supply chain management scenarios. Traceability solutions utilizing blockchain technology have the capability to overcome the limitations of conventional traceability systems(Sunny, Undralla, and Pillai 2020). In contrast to the developed countries, Somalia lacks both the infrastructure and regulations that can ensure food safety and animal as well as plant health. This study aims at examining the factors affecting the formation of a cost-effective blockchain supply chain traceability framework which can facilitate the exchange of information between the Somali Bureau of Standards, commercial firms operating in Somalia as well as consumers to address safety concerns.

Statement of the Problem

Following the elections held in 2012, a new hope of moving forward toward political stability and sustainable development revived in Somalia. Entrepreneurs established numerous businesses including small and medium enterprises.

Real-life on the ground realizes that most of the youth have a passion for entrepreneurship and this had led to the emergence of several new businesses across the country. These enterprises usually import food products from different trade

sources including China and Turkey. Over the last five years, imports of the country have changed by $1.98B from $2.21B in 2015 to $4.2B in 2020.

Although Small and Medium Enterprises (SMEs) doing business in conflict-affected countries such as Somalia is having a unique complexity, the safety of the imported products often needs extra attention and care. Based on the Standards and Quality Control Act Law No. 27 developed in 2020, the government of Somalia established the Somali Bureau of Standards (SoBS). The primary goal of the Somali Bureau of Standards is to create a sturdy quality framework encompassing metrology, standards, accreditation, and conformity assessment, aimed at bolstering Somalia's quality infrastructure.

The development of blockchain-based traceability systems may help and facilitate tracking the origins and sources of the supply in order to safeguard consumers from the importation of hazardous and subpar products into Somalia. This study seeks to investigate the existing traceability systems and government regulations implemented to safeguard consumer safety. Additionally, it will analyze the factors that contribute to the development of a cost-effective traceability system based on blockchain technology, enabling seamless information exchange among importers, government authorities, and consumers.

Purpose Statement

The globalization concept has facilitated the movement of products over continents. Food products are among most commodities that travel across the world and are consumed by different customers. There are relative concerns over the safety of these products. Traceability systems are put in place to address these concerns. Somalia is merely dependent on imported products for its domestic consumption. The primary purpose of this study is to assess existing systems of traceability, rules, and regulations that govern traceability of the supply chains, and factors that affect the formation of a cost-effective blockchain traceability framework which can facilitate the exchange of information between concerned parties and ensure supply chain transparency.

Research Questıon

1. To what extent do the Somali small and medium enterprises trace their supply chain network?
2. What governing rules and regulations motivate firms to develop traceability systems that allow the exchange of information between the Somali Bureau of Standards (SoBS), firms operating in Somalia, and customers to ensure the transparency?
3. What are the contributing factors affecting the implementation of a cost-effective blockchain-based traceability system?

Research Objectıves

The primary objectives of this study involve exploring the application of traceability systems in Somalia and assessing the rules and regulations that ensure compliance with these systems.

General Objectives

The study will examine the status of the application of supply chain traceability in Somalia.

Specific Objectives

- To assess the extent to which the Somali small and medium enterprises trace their supply chain network.
- To assess the existence of governing rules and regulations that motivate firms to develop traceability systems.
- To identify the factors affecting the application of a cost-effective blockchain traceability system.

Geographıcal Scope

The geographic focus of the study was on Somalia, precisely the major cities of Mogadishu, Bosaso, and Kismayo, which boast prominent ports. The aim was to investigate the existing supply chain traceability systems, the regulations governing

them, and the factors that impact the implementation of a cost-effective supply chain traceability framework utilizing blockchain technology.

Time Scope

This study was done in 2022 using primary data from the Somali Bureau of Standards and a sample of SME businesses in Somalia.

Significance of the Study

The results of the research have implications for a wide variety of different types of beneficiaries. Policymakers, the Bureau of Standards, practitioners, and academics are among the groups that will use the findings. The observations of this study provide empirical evidence regarding the condition of supply chain traceability, which holds significant relevance for policymakers in their efforts to establish legislation and regulations aimed at safeguarding the well-being of both individuals and the environment. The observations and conclusions of this study will furnish valuable insights to the Somalia Bureau of Standards, enabling them to assess the current state of supply chain traceability across Somalia.

Additionally, it will illuminate on the readiness of importing companies to support the implementation of laws and standards aimed at enhancing consumer safety. The findings and conclusions of this research will offer practitioners with insights into cost-effective management of the traceability function, utilizing cutting-edge technology such as blockchain. Furthermore, this study offers a practical contribution to academia by addressing the lack of research on traceability in the context of Africa and specifically Somalia. As a result, the research outcomes contribute to the existing body of literature on this subject.

Justification of the Study

Supply chains are becoming increasingly complex as a consequence of the increasing globalization of the economy. A diverse range of products and services are available to customers in diverse locations across different continents. The emergence of these issues poses novel challenges concerning the safety and transparency of the products currently being consumed. Consequently, there has been an increased significance placed on supply chain traceability, particularly within the

food industry following several incidents relating to food safety.(Aung and Chang 2014).

Most of what people in Somalia buy and eat comes from other parts of the world. In 2020, for instance, Somalia spent $4.21 billion on imports. In line with Law No. 27 of the Standards and Quality Control Act, the Somali government established the Somali Bureau of Standards (SoBS) in 2020. (SoBS). In spite of the fact that supply chain traceability is no longer an option, there has been no research done on the application of a supply chain traceability in Somalia. Thus, it appears important to assess the state of supply traceability in Somalia, the laws and regulations governing such systems, and the factors that affect the adoption of a decentralized, low-cost blockchain-based supply chain traceability framework.

Organızatıon of the Study

The study comprises five chapters, outlined as follows: First chapter offers an overview of the research, covering five main components: the research's historical context, the identification of the issue, the studyobjectives, the research questions, the importance of the study, and the study scope. Second chapter comprises a comprehensive literature review, exploring existing research in the field. The second portion of this chapter delves into the theoretical and conceptual foundations.

The third chapter, the methodology, covers aspects such as the design of the research, study population, sample size and sampling procedure,data collection and data analysis techniques. The fourth chapter delves into the study's outcomes and discoveries. Lastly, the fifth chapter delves into the discussion of the results, study conclusion, and researcher's recommendations.

CHAPTER ONE: LITERATURE REVIEW

1.1. Introductıon

Managing the supply chain in today's market is more challenging than ever. This complexity is driven by many reasons such as outsourcing, supplier relations, supply chain networks, technology, regulations, globalization, customer expectations, and product life cycle (Fazli and Masoumi 2012). Since businesses usually seek the supply chain performance gains through integrated global sourcing strategies Sparks and Wagner (2003), it is necessary to foresee the risks as well as assess the supply opportunities(Mayo 2009).

There are emerging concerns over prominent illicit trades, unethical practices of production, vulnerability, disruptions, and safety issues in the supply chain networks. Production firms experience immense pressures from their customers as well as governments regarding production sustainability and transparency. They are expected to develop transparent and measurable approaches to production practices to enhance operational and organizational visibility (Guercini and Runfola 2009).

The fact that today’s market is global has increased the distance between producers and consumers in particular the agri-food products. Final consumers have no direct contact with the producers. The application of a system of traceability will significantly reduce the exposure of risks whereby producers will identify, mitigate, and correct production problems that can lead to health and economic incidents. There is no doubt that the traceability function is an essential quality management procedure that can enhance the efficiency of production control, the collection of related data, and the assurance of quality control(Bevilacqua, Ciarapica, and Giacchetta2009).

The application of Blockchain-based traceability systems will create information trails and ensures the immutability and security of data. Blockchain technology will improve the security of the data and information shared within the supply chain network. Moreover, it will enable the monitoring and control of the product quality, monitoring and control of the production operations, the acquisition of accurate data, as well as improved visibility and supply chain transparency (Azzi, Chamoun, and Sokhn 2019).

1.2.Concept of Traceabılıty

Traceability is considered the ability to trace, track, and monitor products at each stage of the supply chain, including production, processing, and distribution(Moe 1998, Olsen and Borit 2013, Islam and Cullen 2021, Allata, Valero, and Benhadja 2017, Stanciuc and Moga 2014, Millard et al. 2015, Panghal et al. 2018, Ruiz-Garcia, Steinberger, and Rothmund 2010). Hence, traceability is concerned with the procedure of necessary information to keep tabs on the product at every point of the value chain(Banterle and Stranieri 2008). It involves guaranteeing the capability to track the historical background, processes, and whereabouts of a product through documented and distinguishable data within the network of the supply chain. To achieve this, businesses should keep the records of their suppliers, and customers while exchanging that information with the concerned units in the supply network (Bechini et al. 2008).

Traceability holds a crucial role as a strategic service in every business. Its main purpose is to enhance product security and quality control. Additionally, traceability plays a vital role in combating fraud and addressing safety concerns.(Hu et al. 2013). Olsen and Borit(2013), argue that traceability encompasses the capacity to retrieve product information throughout its complete life cycle using pre-existing identification methods. Supply chain traceability, it is pointed out, is not merely the information about the process or product itself, but rather the tools that enable the provision of this information when required during subsequent stages(Karlsen, Olsen, and Donnelly 2010).

Traceability systems may be utilized to handle a variety of issues arising product contamination that and can be tracked from the beginning of raw materials to the end-users. The basic idea behind a food traceability system is to gather, record, retain, and apply information all along the supply in order to assist tackle with issue of crisis management brought on by breaches of food standards and safety. To mitigate the potential consequences of food contamination, the application of a system of traceability offers significant advantages. This system operates by scrutinizing various sources such as documentation, product records, and inventory levels to ensure that food products are safe for consumption(Zahrah, Arkeman, and Indrawan 2021).

The rising consumer preoccupation with food origins and quality has resulted in a prevailing inclination to invest supplementary funds for food products that possess verified origins. Despite the utilization of sophisticated technologies, it is noteworthy

that the majority of traceability systems currently in place tend to be concentrated, imbalanced, and lacking up-to-date mechanisms for data exchange and interoperability. Due to the absence of a reliable and quick method of retrieving information on the product's origin, current systems lack transparency and customers' trust.

To ensure traceability, a significant quantity of related data needs to be collected throughout the supply chain. Initial techniques of tracking relied on employees making notes in the field and then entering them by hand into manuals or computers. This strategy is not without its drawbacks, such as inaccurate information capture and ineffective use of available resources(Demestichas et al. 2020). Traceability encompasses the systematic collection of data pertaining to the origins of a product's raw materials, its processing stages, and its whereabouts at different junctures along the supply chain.

Furthermore, it serves as a tool for monitoring and facilitating communication to ensure information availability throughout the supply. Advanced traceable technologies such as radio frequency identification (RFID) and DNA barcoding have been employed to manage traceability. In the past decade, consumers have reoriented their focus from price considerations to concerns regarding safety, quality, food authenticity, transparent labeling, and product transparency.

In response to this evolving consumer landscape, businesses operating within the food production and distribution chain are increasingly compelled to establish a system of traceability. Integrating the system of traceability and the supply chain network is commonly known as "traceability implementation." This indicates that the system can collect, analyze, and convert product information in a standardized way, and share the information with the various participants in the supply network.

In practice, most traceability systems heavily rely on information and communication technology (ICTs)(Haleem, Khan, and Khan 2019). The study of value chain traceability has become more significant in recent years.

This rising interest in research has been greatly influenced by the pressing requirement for quality and safety, particularly in the pharmaceutical, and food production and distribution networks. Additionally, the recent emergence of new technologies that are expected to have a big effect on traceability. Each and every technological advancement comes with a unique set of benefits and drawbacks; yet,

some technologies are superior to others in certain markets owing to the particular product qualities they provide (Razak, Hendry, and Stevenson 2021)

1.3.Traceabılıty Systems Characterıstıcs

The Food Standard Agency, an autonomous organization responsible for food safety, has outlined the essential components of traceability systems. These include the identification, distribution, and movement information of units, as well as the presence of a data center system. In order to be traced, an item must be considered a traceable resource unit (TRU). These traceable units can encompass batches, trades, and logistics(Montet and Dey 2017).

The characteristics of an efficient traceability system can be categorized intodepth,breadth, and precision. Depth is the capability of the system to trace product information forward and backward, breadth is the size of the information that has been collected, while precision is the assurance to identify the movement of the products (Karlsen, Olsen, and Donnelly 2010).

The traceability system is paramount in food production and distribution network as it tackles various critical issues. It effectively addresses the rising number of food crises that arise from limited knowledge about product safety and quality. Additionally, it helps to minimize the risk associated with unmonitored goods, ensures adherence to policy requirements, reduces the cost of product withdrawals by providing accurate information about specific items, and enhances public health protection by enabling better examination of the origins of foodborne diseases.

In electronic-based traceability systems, two prevalent information flow models are commonly utilized: the forward and backward one-step models, and the aggregated information model (Hayati and Nugraha 2018).

Traceability can be classified into six essential parts: product traceability, traceability of inputs, process tracking, pest tracing, genetic tracking, and tracking measurement (Opara2003). Perez-Aloe et al. (2007) state that traceability can be categorized into internal whereby product information such as batch and history are traced, or external whereby production from raw material through movement, warehousing, and distribution are traced.

However, According to Aung and Chang (2014), traceability can be classified by looking at the activities and sources of information in the supply chain. He argues that there are three types of traceability; suppliers' traceability; process traceability; and customer traceability.

1.4.Types Of Traceabılıty Systems

Banterle and Stranieri (2008)propose that systems of traceability can be classified by two distinct typologiesbased delineated by the management of product movement (precision), and the magnitude of recorded information (breadth). These two types are the "supply chain traceability system" and the "supply chain and product traceability system".

1.4.1. Supply Chain Traceability System

The supply chain traceability system operates by recording necessary information to streamline the identification process of supply network participants. This system of traceability is a requirement in Europe. General food law (Reg. 178/2002) ensures the application of this system. Article 18 stipulates that every person participating in any phase of manufacturing, processing, and distribution throughout the supply network must be recognized.To comply with this regulation, operators must establish standard procedures that allow authorities to access and obtain this information.(Charlier and Valceschini 2006).

1.4.2. Supply Chain and Product Traceability

Considering the increased breadth and precision, the supply network and product traceability system appear to be more intricate than the supply chain traceability system.This form of system is known for its character of managing both products and raw materials in separate batches.

Moreover, this system ensures the implementation of procedures that relatesdetailed information to every batch. Identificationand divisionare done at the arrival of the raw materials, production stage, packaging, or warehousing of finished products. This system aims at achieving a higher level of product safety and quality assurance (Banterle and Stranieri 2008).

1.5.Traceabılıty Costs

The development and application of a supply traceability system require a substantial budget. According to Bosona and Gebresenbet (2013), investments in traceability systems are resource and capital-intensive. A firm's decision to implement a traceability system will necessitate a reevaluation and potential modification of well-established business processes.

Furthermore, capital will be allocated towards new ICT equipment, while experts will be required to train staff and develop new procedures. All of these activities will have a financial impact on the organization's performance (Bosona and Gebresenbet 2013). The regulatory environment, size of the firm, ICT infrastructure, processes of production, product features, organizational structure, supply chain complexity, strategy, and organizational culture, as well as the amount of information to be recorded, will determine the actual costs associated with traceability (Asioli, Boecker, and Canavari 2014).

Investing in traceability systems will result in capital expenditure as well as operating expenses. Table 2.1 differentiates the implementation and operational costs:

Table 2. 1 Types of traceability costs

Type	Implementation	Operational
Effort and time (administration, workforce, and management)	The search for information, Processing, Change management, Tests, and Interruptions	Reporting, Interruption, and Mock recalls
Software and Equipment	Purchases and Installation	Contracts and upgrades
Training	Comprehensive Training	Ongoing, for new staff
Consultants	For system design, Compliances, legislation	Debugging Challenges, Upgrades of Compliances, and legislation
Materials	New system	Labels/Packaging

Audits and Certifications	Audit and certification	Repeat audits/ certification

Source: adapted from Asioli, Boecker, and Canavari (2014)

The application of a traceability system requires a significant investment. These types of systems are designed to ensure the quality and safety of the product.Qian et al. (2020), argues that traceability systems create an economic advantage by reducing the costs associated with product recalls. He further added that the wheat flour milling traceability system created in 2012 was incorporated with RFID, 2D barcode, and QR codes have been implemented resulting in a production cost increase of 17.2%. However, it is reported that sales have increased up to 32.5%.

A supply chain traceability system is an effective tool for enhancing consumer confidence in product safety. The introduction of a traceability system is met with resistance in numerous countries.For instance, firms operating in China are not optimistic about the application of such systems due to the high costs involved. These enterprises believe that the cost of establishing a system of traceability can lead to unwillingness from the supply network participants and concerns about the sustainability of the system(Xu, Zhao, and Liu 2020).

Although there is a huge investment and operational cost associated with the introduction of a system of traceability, it can lead to identifying critical problems pertaining to the quality and safety of the product at an early stage. By implementing traceability systems, organizations can effectively prevent the distribution of unsafe or low-quality products, safeguard their reputation, limit potential liabilities, and minimize the need for product recalls. These systems are put in place to enhance the overall management of the supply network and enable the tracking of products for quality and safety purposes. The anticipated advantages include decreased costs associated with distribution systems, reduced expenses related to product recalls, and the potential for increased sales(Golan etal. 2004).

1.6.The Fundamental Concept of Blockchaın Technology

Blockchain is acknowledged as one of the modern technology trends shaping businesses in the present era.The advent of blockchain technology offers an extensive and revolutionary approach to resolving the trust and transparency issues in business transactions between organizations(Yli-Huumo et al. 2016). This technologywas based

on the phenomenon of avoiding symmetry and repetition of the objects via a decentralized, secure, and transparent, approach (Badhotiya et al. 2021).

The assertion behind the decentralized ledger is to create numerous sources while the dependency on one system is eliminated. This will ensure the provision of a durable system characterized by risk resilience, transparency, and fault detective. Blockchain transaction blockchain technology can lower the cost of transactions, whereby third-party intermediaries are eliminated. Information and data recorded in the blockchainsystem will remain consistent, precise, well-timed, and accessible across the world (Min 2019).

Blockchain is well-known for with secure, transparent, and precise mechanism for business-to-business transactions, particularly financial transactions. The data is embedded within a distributed networked system that makes it transparently accessible. Altering the block data requires an extensive amount of high technology and it is very difficult to acquire such technology power to get ahead of the network and the entire system. This had proved that blockchain-based systems are transparent, secure, and consistent at all levels (Badhotiya et al. 2021).

The exciting world of blockchain has captured the imagination of both the business as well as public sectors. With its potential to transform industries and elevate the efficiency and accuracy of regulatory measures, the widespread adoption of blockchain technology has the power to reshape economic landscapes and revolutionize traditional practices.Both the business and public sectors are buzzing with enthusiasm over the emergence of blockchain technology. This innovative technology acts as the building block for developing peer-to-peer networks that facilitate direct and secure exchanges of data, assets, and digital commodities, bypassing the need for intermediaries.

The widespread adoption and implementation of blockchain technology hold immense transformative potential, capable of revolutionizing various economic sectors and vastly enhancing regulatory measures.When thinking about the disruptive potential of blockchain, it is imperative to take note of the fact thatthe present fourth industrial revolution is framed by the integration of numerous technologies that dissolve the barriers between the cyber and physical domains. Technologies like artificial intelligence, autonomous cars, and cloud computing, to mention a few, may join forces with blockchain to change many industries and the way we live as a whole. In fact, it

would be more instructive to consider how these technologies would deliver efficient and affordable solutions to various sectors (Aste, Tasca, and Di Matteo 2017).

1.6.1. Types of Blockchain

There are public, decentralized ledgers that may be accessed by any anyone with an Internet connection. The public nature of these blockchains stems from the fact that everyone has the freedom and willingness to participate in selecting which blocks are added to the chain and determining its current condition. These blockchains are fully decentralized and depend on a consensus mechanism known as proof-of-work to verify transactions.In a completely private ledger, permits are overseen by a centralized authority figure who makes all of the decisions.

A private blockchain may be thought of as a permissioned ledger, in which the identity of users can be whitelisted or blacklisted according to the results of an organizational process known as "Know Your Business" (KYB) and "Know Your Customer" (KYC). A hybrid between public and private blockchains is constituted by partially decentralized blockchains, which are sometimes referred to as Consortium blockchains (Pilkington 2016).

Blockchain uses a decentralized protocol, which means that rather than having a single, centralized node of control, there are several nodes that are linked to each other. There are no restrictions on who may utilize permission-less blockchains since there is no barrier to entry. Anyone is able to run mining software on a node. Anyone is able to get access to a wallet and put data into the transactions so long as they adhere to the standards established by the blockchain. These blockchains are characterized by their openness and transparency, allowing anyone to scrutinize them at any given time.

They are commonly referred to as public blockchains, in contrast to privately owned blockchains. They operate as a closed system in which users find it challenging to become part of the blockchain network, gain visibility into its history, or carry out transactions. because they need some type of authorization to do so. It may be the property of a private person or of an organization with a centralized authority that is responsible for managing permits. This consortium or federated blockchain eliminates the authority from a single person. Here, authority is delegated not to one central body but to a loose confederation of autonomous organizations. This type of blockchain is sometimes referred to as hybrid (Sheth and Dattani 2019).

1.6.2. Structure of the Blockchain

Blockchain is a decentralized platform that presents a distributed database comprising ledgers, transactions, and digital occurrences.This platform functions as an unchangeable platform for the participating parties. Nakamoto first conceptualized blockchain in 2008 as a means of facilitating peer-to-peer financial transactions using the Bitcoin protocol. Blockchain may be thought of as a chain made up of individual blocks.every block includes its individual set of data, a hash value, and a duplicate of the preceding block's hash.

Characters and digits are merged to create the hash, providing it with its distinctivenessand it serves as the identity for the block. 256-bit hashes are the standard, although larger sizes are possible. For the sake of saving some digits, hashes are often expressed using the hexadecimal system of numbers.

While the decimal system relies on numbers ranging from 0 to 9, the hexadecimal system includes these digits and introduces six additional ones(Moosavi et al. 2021). The distributed ledger, often known as the blockchain, is constructed up of blocks, each of which is appended to the chain at specific time intervals. The information that is included in the blocks is determined by the blockchain network itself; however, the date, transaction, and hash are always present in blockchain.

As seen in figure 2.1, the cryptographic hash of the preceding block is stored within each subsequent block of the blockchain. Hence, it is not possible to change anything included in the hash since it is all created automatically. This applies to all of the information contained in the hash. In this scenario, the verification of the preceding block and the safety of the whole blockchain are strengthened with each subsequent block that is added. The blockchain is considered to be more secure and dependable when there are more blocks on the chain (Golosova and Romanovs 2018).

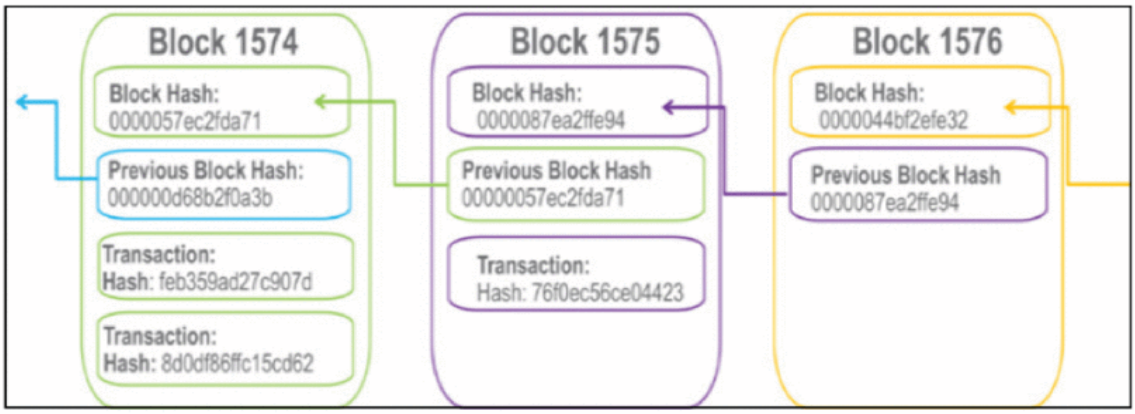

Figure *2. 1 The sequence of the hash value in the Blockchain*

Source: (Golosova and Romanovs 2018)

1.7.Block-Chaın Technology and Supply Chaın Traceabılıty

Supply chain management is placing a growing emphasis on HSE (Health, Safety, and the Environment). To ensure that health, safety, and environmental standards are met, a function traceability system becomes crucial in monitoring business processes. Traditional tracking techniques, such as scanning, checkpoints, and barcodes, often provide only partial data. However, the emergence of IoT technologies, such as RFID, has now made it possible to automatically monitor and trace supplies with minimal operational expenses.

Businesses widely utilize RFID to track inventory information and monitor employee activity. The Internet of Things (IoT) has revolutionized supply chain management by enabling the traceability of items throughout the entire supply network, a feat previously unattainable with conventional technologies.(Zhou and Piramuthu 2015). However, solutions based on Blockchain technology have recently gained momentum and popular acceptance among supply chain management perspectives. Blockchain offers a transparent and traceable approach to handling business transactions between participants who don't trust each other (Queiroz, Telles, and Bonilla 2019).

Transparency in supply chain management is an emerging feature of today's competitive business environment whereby safety and product quality are major concerns. The collaboration between supply chain partners dictates a need for a significant level of security and transparency (Hugos 2018). The use of blockchain to enhance traceability, auditability, and transparency of the materials' movement

between supply networkstakeholders is unavoidably going to increase. Blockchain has already shown its effectiveness as a supply chain traceability system, and this trend is likely to continue (Song, Sung, and Park 2019).

The execution of a system of traceability is a complex task since it involves re-engineering the entire system with new technology and high capital cost. The adoption of blockchain technology to trace product safety will ultimately result in a positive financial performance by improving firms' brand, reputation, market share, and confidence of the customers. In addition to that, blockchain technology will facilitate effective supply chain management practices whereby product recalls are accelerated and liability risk is reduced(Xu, Zhao, and Liu2020).

The application of blockchain will ensure transparency of the products's information at any stage of the supply chain. It will allow all nodes at every stage to see the information that is relevant to the business transactions.Moreover, transparency will create a credible, trustworthy way for recording data, auditing, tracking, and securing product safety. In addition to that, blockchain can easily facilitate tracing the relevant information about the supply chain.

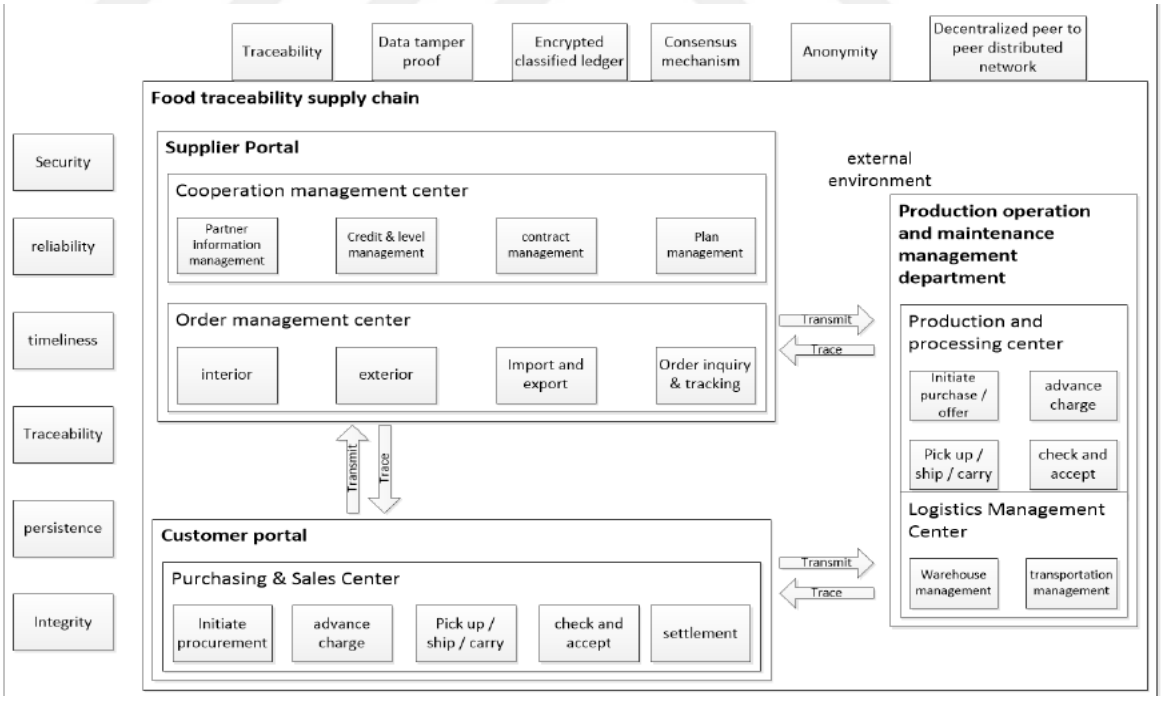

Figure 2. 2 Traceability System based on Blockchain Technology

Source: (Xu, Zhao, and Liu 2020)

1.8.Theoretıcal Framework

Systems of traceability prove to be beneficial in dealing with matters involving the quality concerns as well as issues related to safety of products.There are an investment and operational costs involved in developing such systems. Literature shows that the traditional supply chain traceability systems can impact a firm's financial performance; hence, these firms are not willing to implement these systems. According to Xu, Zhao, and Liu (2020), data related to the supply chain is cooked and falsified which in turn can harm the safety of the consumers. In today's consumer mindset, transparency and traceability are deemed crucial factors when it comes to ensuring the well-being aproducts(Roth et al. 2008).

Somalia's domestic consumption is dependent on imported commodities. There are growing concerns over the safety and quality of imported goods. In order to tackle these apprehensions, the Somali Bureau of Standards (SoBS) was instituted in accordance with the Standards and Quality Control Act Law No. 27 of 2020. The bureau has been granted comprehensive jurisdiction over the oversight of product quality and safety.

However, it faces challenges due to inadequate infrastructure and regulations, hindering its ability to assure the importation of safe and standard goods. The introduction of traceability system built on blockchain functionality will address all problems related to product quality and safety. Blockchain technology enables building trust and cooperation among supply chain partners by improving the persistence, transparency, and integrity of the supply chain and allows government authorities to monitor and access supply chain-related data.

The overall theoretical foundation of this study is based on the theory of transaction cost economics. TCE asserts the possibility of finding an alternative approach to the traditional mainstream economics through the lens of choice. Considering the opportunism and bounded rationality concepts, the exchange of economic activities can be perilous to one's health; therefore, parties seek a cost-effective form of governance that can mitigate foreseeable problems (Williamson 2008).

This study aims at examiningthe possibility of developing a cost-effective blockchainsystem of traceability identifying requirements from the viewpoint of

government and local firms and recognizing the critical success factors. The suggested framework will facilitate the creation of a distributedsystem of traceability in which participants in the supply network would recordall related data. For instance, businesses will enter all information pertaining to imported goods into the system so that they can be tracked at any moment. Similarly, the Somali Bureau of Standards will have access to the data more easily.

The system will also be accessible to consumers so that they may report problems involving the safety of ingested products. Upon receiving a complaint of an occurrence, the Bureau may investigate the claims made by customers and, if necessary, issue a recall to protect the public from potentially dangerous goods. Figure 2.3 shows how partners work together to share information about the supply chain.

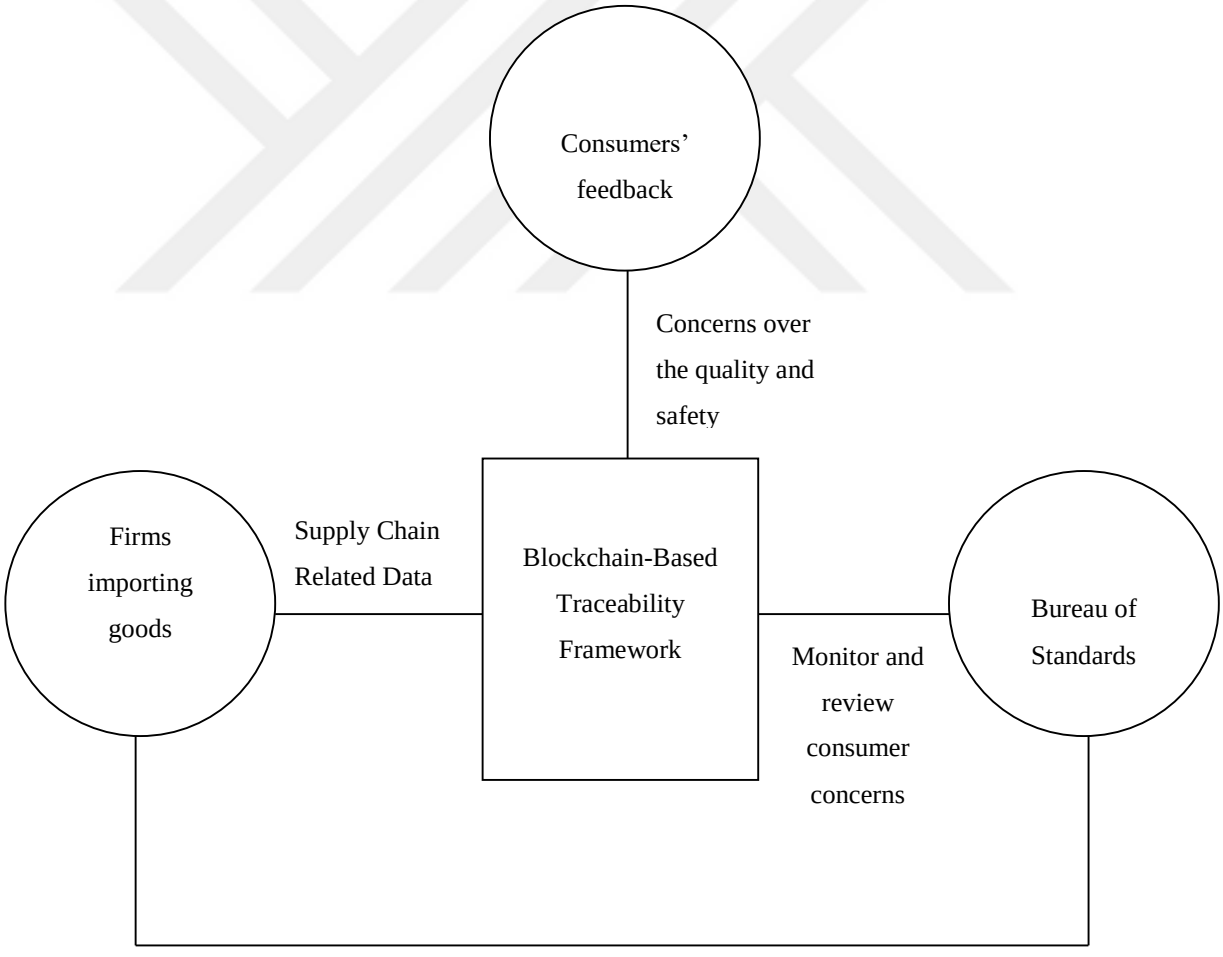

Figure 2. 3 Theoretical Framework

CHAPTER 2: METHODOLOGY

2.1. Introductıon

The political stability of Somalia has allowed various entrepreneurs to start companies around the country. These companies are primarily engaged in the process of importing goods from a broad range of commercial channels. When doing so, companies are responsible for considering the questions regarding the quality and safety of imported goods. The goal of this research is to determine what elements affect the creation of a low-cost blockchain-based supply chain traceability framework that can effectively solve issues of quality and safety.

The evaluation will make a sizeable contribution, for the benefit of both customers and the environment, to the enhancement of safety measuresFor the purpose of carrying out this study, structured data has been gathered, examined, and evaluated across the board from all of the major participants. These major players include small and medium businesses that bring items into Somalia, as well as the Somali Bureau of Standards. This chapter will go into detail about the methods that has been utilized to collect and analyze the data.

2.2.Type of Research

A mixed-mode strategy has been used to investigate what aspects impact the creation of a low-cost blockchain-based supply chain traceability framework. Data from small and medium-sized businesses (SMEs) involved in Somalia's import industry has been gathered using a quantitative survey approach. The senior management of the Somali Bureau of Standards has been interviewed for the purpose of gathering qualitative data.

The methods of data collection utilized in this study were written questionnaires designed according to a Likert scale with five points, and interviews. The questionnaire was distributed to importers of commodities into Somalia. In order to acquire the necessary information from the Somali Bureau of Standards administration, interviews have been conducted. The drop-off/pick-up (DOPU) method has been utilized by the researchers.

This method contributes to the reduction of noncoverage errors and potential sample bias without lowering the response rate. Additionally, this approach's strength

is that it will lessen the impact of interviewer bias because it lets respondents complete the questionnaire on their own.

2.3.Partıcıpants of the Study

In order for this study to accomplish its purpose, main attention has been paid to both the senior management at the Bureau of Standards as well as small and medium-sized businesses that bring commodities into Mogadishu. As a result of the relatively high level of competition in the market and the practitioners' reluctance to provide sensitive information to the researcher, the research will make use of purposive sampling techniques. In these situations, the researcher chooses who will take part in the study. One hundred and eighty (180) questionnaires in all have been administered to the top and middle management of these companies.

2.4.Data Collectıon Technıques and Procedure

Interviews, as well as structured self-administered questionnaire, were utilized to collect data from the participants in the study, and these methods were used to obtain both quantitative and qualitative information. To verify the validity and reliability of the data reported in this study, a thorough check has been carried out on the instruments used for data collection.

2.5.Data Analysıs

3.5.1. Quantitative Data

To provide a concise summary of the information (data) acquired from the respondents, descriptive statistics have been utilized. Using descriptive statistics like mean, frequency, and standard deviation, we may examine how various groups of sample units fare in terms of our independent variables of interest. Utilizing the SPSS, the data from the questionnaire were first structured, and then coded, before being placed into a computer.

3.5.2. Qualitative Data

To collect qualitative data from key informants, the researcher employed open-ended questioning techniqueswhile taking notes. By conducting qualitative data analysis, it became possible to recognize similarities and differences, which were then

labeled and coded.Content analysis was used to sort out and categorize any verbal or behavioral information that needed to be classified. The gathered data were summarized and then tabled in order to make sense of them and to place emphasis on the most important messages, traits, or discoveries.

CHAPTER 3: RESULTS

3.1.Introductıon

The study's findings are disclosed in this chapter. These findings have been obtained by analyzing data collected from the Somalia Bureau of Standards, along with data from businesses involved in the importation of goods into Somalia.The data in this chapter were examined using a descriptive methodology. The response rate, reliability, and overall data quality are all discussed in this chapter. This chapter will also discuss the extent to which small and medium-sized businesses in Somalia trace their supply chain networks, the factors that affect the adoption of a cost-effective traceability system integrated with blockchain functionality, and the regulatory norms that incentivize businesses to implement supply chain traceability systems.

3.2.The Qualıty of Data

3.2.1. The Response Rate in the Study

The term "response rate" refers to the proportion of instruments used to gather data that were returned by the study's participants. Response rates for samples returned to the study are reflected in the range of responses. Below in Table 4.1, you will find a concise representation of the response rate findings.

Table 4. 1Response Rate

Method	Target	Responses	Percentage
Questionnaire	180	150	83
Interview	6	6	100
Total	186	156	83

Source: Author (2022)

Observing Table 4.1 reveals that the questionnaire in the study achieved an 83% response rate, while the interview achieved a 100% response rate. There were a total of 150 questionnaires that were returned for the study, and there were also respondents who participated in the study by way of interviews.

Sample size was modified to account for the missing questionnaire. The sample size was 156, made up of individuals who filled out 150 questionnaires and 6 interviews.

3.2.2. Reliability Statistics

The data that were collected were thoroughly cleansed and then arranged.The reliability of the scale was assessed through the application of Cronbach's Alpha.The findings are summarized in Table 4.2 below. The results demonstrate a high level of consistency in the data collection process, with a Cronbach's Alpha value of 86%.

Table 4. 2Reliability Statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
.862	29

Source: Author (2022)

3.3.Respondents' Personal Informatıon

The study found that 90% of respondents were men. The vast majority of those who participated were upper-level managers in various departments or the organization as a whole. The study results unveiled that 86% of the respondents possessed a tenure of experience varying from two to ten years.In addition, 86 percent of those who participated in the survey had completed high school or more than one year of college.

Table 4.3 presents both the frequency and the percentage distribution of the respondent's personal information.

Table 4. 3Personal Information and Business Characteristics

Characteristics	**Frequency**	**Percent**
Gender		
Male	135	90
Female	15	10
Position		
Manager General	30	20
Head of Department	60	40

Project Manager	29	19.3
System Operator	10	6.7
Other	21	14
Experience		
1year	11	7.3
2-5 year	77	51.3
5-10 year	49	32.7
>10 year	12	8
Educational background		
High school	78	52
College	32	31.2
Undergraduate	28	18.7
Postgraduate	12	8

Source: Author (2022)

3.4.Characterıstıcs of the Fırms

According to the findings of the study, just 10% of the companies were traded publicly, while the remaining 90% were privately owned. The majority of businesses, 83%, were found to have fewer than 100 workers. Almost two-thirds of these corporations import food and agricultural products from other countries. According to the findings of the study, the supply chain does not provide an excessive level of complexity, yet there are product or service risks associated with more than forty percent of these firms. Table 4.4 displays the frequency and percentage distribution of the following company characteristics:

Table 4. 4Characteristics of the Firms

Characteristics	**Frequency**	**Percent**
Firm ownership		
Public	15	10
Private	135	90
Employees		
Below 100	124	82.7
Above 100	26	17.3

Commodities		
Raw material	39	26
Food production	55	36.7
Agricultural products	23	15.3
Construction material	33	22
Product/service risk		
High	66	44
Low	84	56
Complexity		
High	22	14.7
Medium	101	67.3
Low	27	18

Source: Author (2022)

3.5.The Extent To Whıch Somalı Small and Medıum Enterprıses Trace Theır Supply Chaın Network

Due to the fact that globalization has made it easier to move goods between continents, food products now have the ability to travel all over the world and be consumed by a variety of different clients. The safety of these items is becoming an increasingly pressing issue. To trace the root of these goods, systems of traceability are implemented.

One of the goals of this research is to ascertain the level to which Somali small and medium firms are able to track the network of suppliers who provide their goods. In order to get a clearer picture, we asked respondents to characterize the present state of supply chain traceability at their company.They were asked the level of support and position held by the senior management of their companies in relation to the adoption of a system of traceability.

In addition, participants in the study were questioned regarding the procedures that they followed while dealing with non-conforming items, contamination, and quality control as part of the management system. The sections that follow will present the findings of each component in accordance with the respondents' opinions.

3.5.1. Supply Chain Traceability Status

The research looked at how well-established small and medium-sized businesses in Somalia have a system of traceability. To gain comprehension of the viewpoints held by these organizations regarding the implementation of a traceability system,the respondents were questioned whether or not their companies had developed a functioning supply chain traceability system and whether or not traceability is considered a key concern in their companies.

In addition, respondents were asked if there are governing rules and regulations that require them to set up such systems. They were also asked what customers do when there is a quality issue over the things that they purchase and how they react to that. Finally, participants were asked if there are procedures in place along the supply chain for handling concerns of contamination, quality, and non-conformance. Table 4.5 displays the results of the calculations that were done to determine the mean and the standard deviation of each factor. According to the respondents of the study, organizations conducting business in Somalia have established functional supply chain traceability systems.

The prevailing opinion among the respondents was that their organizations had effectively implemented an internal traceability system. Table 4.5exhibits that the mean of having functioning system of traceability within the firms in Somalia is (3.91). According to the study's findings, participants concur that businesses are worried about supply chain traceability issues since they are considered as a means to safeguard brands and raise consumer satisfaction.

Table 4.5 demonstrates that companies operating in Somalia are very concerned about supply chain traceability, with a mean score of 3.99 on a scale from 1 to 5 regarding how much importance they place on supply chain traceability systems inside the firm for brand protection and customer satisfaction. Participants in the survey claimed that no laws or regulations exist that mandate businesses set up supply chain traceability procedures to determine the origins of imported items.

The vast majority of respondents acknowledged that they were not compelled by any rules or regulations to establish a traceability system, which is consistent with

the mean shown in Table 4.5. The study's respondents were questioned about whether or not the businesses in Somalia have procedures in place for addressing supply chain issues such contamination, quality, and non-conformance. The study's respondents indicated that their organizations have formulated rules regarding contamination, quality, and non-conformance within the supply chain.

As shown in Table 4.5, the average number of firms with policies and procedures for contamination, quality, and non-conformance is 4.08. This means that most of the companies doing business in Somalia have made these protocols.The research found that when consumers buy products, they complain and ask for product recalls if there are quality issues. According to the descriptive analysis, respondents are in agreement that customers will seek a replacement or return for products that have quality flaws.

There were a few respondents who indicated that customers don't bother to ask about or return products if there's a problem with the quality of the item they purchased. Table 4.5 shows that the average number of customers who want a response to their complaint and a product recall when there is a problem with quality is 3.83. This means that customers tend to file complaints when there is a problem with quality.

Table 4. 5Current Status of the Supply Chain Traceability

Statement	Observations	Mean	Std. Deviation
We have established a functioning supply chain traceability system within our organization	150	3.91	1.170
Supply Chain Traceability is given s major concern in our firm and is seen as vital function for brand protection and customer satisfaction	150	3.99	1.117
There are governing rules and regulations that forces organizations to establish supply chain tractability system	150	1.43	0.855

Customers tend to demand complain response and product recalls when quality issues arise	150	3.83	1.028
Our organization has implemented robust protocols and procedures to address supply chain contamination, ensure product quality, and effectively manage non-conformance issues.	150	4.08	4.239

Source: Author (2022)

3.5.2. Top Management Support

The study looked at how committed top management was to setting up supply chain traceability systems in their companies. In order to get insight into whether or not business executives are prepared to support the implementation of supply chain traceability, a question was posed to respondents asking whether or not the top management of their respective firms regards supply chain traceability as a strategic priority. This information was gathered to better understand the level of preparation of business executives.

Respondents were also asked if a dedicated budget for supply chain traceability was allocated to assure the availability of all necessary data about the supply network. In addition, respondents were asked about the perspective of senior management on supply chain traceability as a competitive advantage for their companies. Table 4.6 exhibits the results obtained from the calculations carried out to ascertain the mean and standard deviation for each factor. Respondents said that the top management of companies operating in Somalia did not consider traceability to be a strategic objective.

Majority of the participants held the viewpoint that chief executive officers or owners of the businesses they collaborate with are typically moderate in their level of commitment to the supply chain traceability function as a strategic objective. Table 4.6 provides a summary of the study findings, indicating an average perception score of 2.78 among top management regarding the supply chain traceability system as a strategic priority.Additionally, the respondents disclosed that the top management of

their individual companies has not designated a specific budget for supply chain traceability.

Table 4.6 reveals that the mean allocation of dedicated budgets for supply chain traceability by top management is 1.81, showing that owners and CEOs of companies operating in Somalia do not designate separate budgets for traceability issues. According to study participants, traceability is not considered as a competitive advantage by the top management of their respective companies. The overwhelming majority of respondents acknowledged that company owners, CEOs, and managing directors do not believe that the traceability function can help the firm maintain a competitive position in comparison to its rivals.

Table 4.6 shows that the average top management perception of supply chain traceability systems as a competitive advantage within supply chain management is 1.44.

Table 4. 6Top Management Support

Statement	**N**	**Mean**	**Std. Deviation**
Traceability is regarded as a strategic priority by the leadership	150	2.78	1.370
The top management allocated a budget for supply network traceability	150	1.81	1.071
The top management recognizes traceability as a key driver of competitiveness	150	1.44	.498

Source: Author (2022)

3.5.3. Non-Conforming Processes and Procedures

The research looked into the practices put in place by firms in Somalia to identify supply chain problems such as contamination, poor quality, and non-conformance. In order to comprehend these processes and procedures, respondents were questioned regarding the existence of procedures to detect contaminated items and products with quality issues. In addition, respondents were asked whether or not

response actions are performed whenever contamination, quality, or non-conformance events occur inside their supply chain.

Furthermore, the participants were asked whether their respective companies have a tendency to effectively resolve issues related to contamination, quality, or non-conformance problems within their supply chains. Table 4.7 displays the results of the calculation of each factor's mean and standard deviation. Respondents to the study reported that their companies routinely identify problems with contamination, quality, or non-conformity within their supply chain.

The majority of respondents agreed that their organizations tend to identify supply chain management flaws and problems related to contamination, quality, or non-conformance issues early. According to Table 4.7, the average threshold for identifying quality, non-conformance, or contamination is 3.34.

In addition, the respondents disclosed that their respective companies take action in the event of contamination, quality, or non-conformance issues in the course of managing the supply chain. According to Table 4.7, the mean number of responses to detected contamination, quality, and non-conformance events within the supply chain is 3.53. As a result, remedial steps could be devised to ensurethe customer well-being and happiness with the product.

Participants in the study were asked if their companies recover from the effects of contaminated products, products with quality problems, or other non-conformance events in their supply chain. According to the study findings, most businesses are able to bounce back after experiencing issues with contamination, quality, or non-conformance. As shown in Table 4.7, the supply chain's mean recovery time from contamination, quality issues, and non-conformance events is 3.49, thus the majority of the companies won't experience substantial effects.

Table 4. 7Non-Conforming Processes and Procedures

Statement	**N**	**Mean**	**Std. Deviation**
Identify instances of contamination, quality deficiencies, or non-conformances within our supply chain.	150	3.34	1.181

Responses are initiated to rectify a contamination, quality issue, or non-conformance event occurring in our supply chain.	150	3.53	1.072
An established recovery process is enacted subsequent to a quality issue, non-compliance, or contaminationevent within our supply chain	150	3.49	1.122

Source: Author (2022)

3.5.4. Management Systems

The study looked at how the companies' management systems let them communicate with their partners and suppliers about quality problems, nonconformities, and contaminations that might happen in their supply chain.

Respondents were asked what would happen if suppliers didn't follow the procedures for quality, non-conformance, and contamination incidents. They were also questioned on the requirement for supply chain partners to deliver actionable information in response to non-conformance, quality, and contamination problems. In addition, respondents were asked whether or not their companies communicate timely data with their suppliers in order to respond to events including quality, contamination, and non-conformance.

The participants of the study were questioned regarding the methods that can be utilized to communicate with partners in the supply network in an effort to address non-conformance, contamination, and quality issues accordingly. The prospect of cooperation amongst supply partners to enhance the programs relating to the quality, compliance, and contamination components of the supply chain has also been discussed by respondents. Finally, respondents were asked if their companies conduct audits to assess whether or not connections with supply chain partners should be maintained. Each factor's mean and standard deviation were computed, and the findings are demonstrated in Table 4.8.

Respondents attested that businesses describe the repercussions of failing to adhere to protocols for recognizing quality, impurity, and nonconformance events

within their supply network. The respondents were in agreement that supply chain partners were subject to specific repercussions if they failed to comply with their company's policies and proceduresthat have been put in place to detect defects as early as feasible. Table 4.8 exhibits that the mean of the defined consequences for not following procedures is 3.14.

The respondents also mentioned that their respective companies require their supply partners to give them the information they need to take corrective actions in the process of responding to contamination, non-conformance, and quality events. This would enable them to take corrective action for any quality-related issues with the products served to customers. The mean value of asking partners to give actionable information in order to respond in an accurate and timely manner to problems involvingquality, contamination, and non-conformance is 3.19, as shown in Table 4.8.

Participants were asked if their organizations promptly communicated information about contamination, nonconformance, or quality event to other parties in the supply chain. Study participants reaffirmed that their organizations routinely and promptly share data with their partners to integrate the appropriate reaction to quality defects, contamination, and non-conformance situations. According to Table 4.8, the average number of firms that provide timely data to their suppliers in order for them to successfully respond to faults of contamination, quality, and non-conformance events in the supply network is 3.46. Hence, majority of businesses are taking preventative measures to deal with faults that occur in the supply chain.

The respondents were also questioned on the responsiveness of their companies' communication with their supply partners in the face ofcontamination, non-conformance, and quality incidents. The vast majority of respondents claimed that their organizations maintain open lines of communication with their supply partners to facilitate the timely dissemination of important details. According to table 4.8, the average number of firms that communicate with their suppliers in a timely manner and inform them of faults in contamination, quality, and non-conformance events in the supply network is 3.62.

As a result, the majority of businesses are closely connected with their suppliers, and as a result, response actions are taken accordingly.The study's respondents were questioned regarding the cooperation between their companies and supply chain partners to enhance procedures for identifying and responding to quality, non-

conformance, and contamination events. According to the respondents, there is an established level of coordination between the companies and their supply chain partners, with the goals of increasing quality, lowering contamination rates, and putting into place non-conformance programs.

According to the data shown in table 4.8, the mean value of working with partners is 3.57.Finally, respondents were questioned regarding the use of audits to assess whether or not ties between businesses and their partners will be preserved. The majority of respondents indicated that their companies have implemented an audit procedure to evaluate their relationships with supply partners.

The mean for using audits to determine the relationship with suppliers is 3.65, as shown in Table 4.8; as a result, the majority of these organizations decide whether the relationship is maintained or not.

Table 4. 8 Management Systems

Statements	**N**	**Mean**	**Std. Deviation**
Enforces penalties for partners who disregard the prescribed procedures and guidelines regarding standards, contamination, or compliances	150	3.14	1.243
Mandates that our partners share with us necessary and relevant data that enables our company to effectively address and manage an incident involving contamination, quality issues, or non-conformance.	150	3.19	1.079
Promptly delivers appropriate data to our supply chain partners in order to effectively respond to an incident involving contamination, quality deficiencies, or non-conformance issues.	149	3.46	1.023

Promptly engage in effective communication with supply chain partners to address cases of contamination, quality issues, or non-conformance	149	3.62	1.068
Collaborate with partners in improving their quality, contamination, and compliance programs	150	3.57	1.019
Utilizes audits as a means of assessing whether to sustain collaborations with supply chain partners.	150	3.65	1.055

Source: Author (2022)

3.6.Factors Affectıng The Implementatıon of A Cost-Effectıve Blockchaın-Based Traceabılıty System

The significance of systems of traceability within the supply network has grown considerably in recent years, especially in regard to enhancing consumer safety for products like food and other goods. Implementing an effective traceability system that can provide accurate information has become crucial. However, the application of these systems is affected by various factors. These factors differ as per the economic scale of firms and the particular countries they operate in. Hence, the objective of this research is to assess the obstacles hindering the adoption of blockchain-based system of traceability in Somalia.

Respondents were requested to provide a description of the existing laws and regulations that govern the development and adoption ofa system of traceability in Somalia. This was done with the intention of gaining a better understanding of the situation. Additionally, respondents were asked about financial sources for establishing traceability systems and the backing of current cutting-edge technologies. The findings of each component will be presented in accordance with the opinions of the respondents in the sections that are to follow.

3.6.1. Regulation

The study investigated the regulatory issues that affect the adoption ofefficient and cost-effectiveblockchain-based traceability system in Somalia. In order to determine the regulatory elements that contribute to development and adoption of a blockchain system of traceability, respondents were questioned regarding the existence of traceability legislation, standards, and regulations.

They were also asked if Somalia has policies and rules that make it easier to set up a supply chain traceability system that doesn't cost too much. In addition, respondents were questioned if there were any regulatory authorities that kept an eye on and monitored the traceability operations of businesses. In Table 4.9, you can find the results of computing the mean and standard deviation for each factor.

Respondents acknowledged the absence of traceability rules and regulations in Somalia, which hinders the implementation of cost-effective blockchain system of traceability across enterprises operating in the country to guarantee their capacity to trace their supply chain network and protect customers and the environment. The vast majority of respondents concurred that there are currently no existing regulations pertaining to traceability.According to Table 4.9, the mean absence of traceability laws and regulations in Somalia is3.65.

The respondents in the study highlight that the absence of traceability standards hampers the widespread acceptance of a blockchain-based traceability system in Somalia.Based on the findings presented in Table 4.9, the average score for the absence of traceability standards is recorded as 3.61. This signifies a significant variable contributing to the barriers faced in the implementation of a traceability system within the country. Participants consistently reported a lack of policies in Somalia that support or provide guidance for the adoption of traceability practices.

The respondents acknowledged that the lack of a policy guide hinders the deployment of the traceability systemwhich is consistent with the mean (3.49), as shown in Table 4.9. Respondents to the survey were also asked about regulatory bodies and their effects on the deployment of a cost-effective system of traceability in Somalia.The participants in the study noted that one of the obstacles to the application of a blockchain system of traceability in the country is the lack of a regulatory agency. According to the findings presented in Table 4.9, the mean score for the absence of

regulatory bodies is 3.62. As a result, regulatory bodies ought to be established in Somalia in order to implement a robust and trustworthy traceability system.

Table 4. 8 Laws and Regulation

Statement	N	Mean	Std. Deviation
Absence of traceability laws and regulations	150	3.65	1.055
Absence of traceability standards	150	3.61	1.073
Absence of policy guide for implementing traceability systems	150	3.49	1.122
Absence of regulatory bodies	150	3.62	1.066

Source: Author (2022)

3.6.2. Investment Opportunities

The study looked at how government and private sector investment interventions affected the rollout of supply chain traceability systems that used blockchain technology in Somalia. Respondents were questioned on the contribution of government financing that assists businesses in the implementation of cost-effective traceability systems within their supply networks to deeper understand the phenomenon. Respondents were also asked about the effect of corporate investment in the implementation of supply chain traceability systems.

Additionally, participants were asked about the impact of investment made in system management and maintenance in the effort to implement a blockchain-based traceability system. Finally, participants were inquired about the impact of consumer willingness to purchase traceable products. The results of this calculationare displayed in Table 4.10. Participants in the study attested that financing and support from the government will encourage the innovation of a systems of traceability in the nation. Respondents concurred that funding opportunities would make it simpler to set up a cost-effective blockchain-based traceability system in Somalia, enabling businesses and regulatory agencies to track incoming goods and verify that safety standards are met. According to Table 4.10, the mean government funding for traceability system implementation is 3.14.

According to the study respondents, a critical factor influencing the adoption of a blockchain-based system of traceability in Somalia is the allocation of a specific

budget for investing in the system. Table 4.10 reveals that the mean value for the corporate budget designated for investment in the traceability system is recorded as 3.19. This suggests that the availability of financial resources may have a considerable impact on the successful introduction of the systems of traceability within the country.

The participants in the study noted that investments in system operation and maintenance are also contributing factors to the implementation of blockchain-based and a cost-effective traceability system in Somalia. According to the vast majority of respondents, investing in system operation and maintenance will make it easier to adopt a traceability system, which is consistent with the mean of 3.45, as demonstrated in Table 4.10.

In addition, participants werequeriedabout the contribution of consumers who are willing to purchase traceable goods. According to the participants in the study, the willingness of consumers to purchase products that can be traced is a factor that might positively contribute to the implementation of a blockchain traceability system in the country. The mean value for consumer willingness to pay for traceable food, as indicated in Table 4.10, is 3.63; hence, customers' commitment to consuming traceable products may greatly contribute to the development of a cost-effective traceability system.

Table 4. 9Traceability Investment

Statement	**N**	**Mean**	**Std. Deviation**
Government Funding for traceability system implementation	150	3.14	1.243
Cooperate budget for investment in traceability system	150	3.19	1.079
System operation and maintenance investment	150	3.45	1.027
Consumer willingness to pay for traceable food	150	3.63	1.071

Source: Author (2022)

3.6.3. Technology Support

The study looked at how government support for technology may affect the implementation of blockchain supply chain traceability systems in Somalia.The

participants were questioned regarding the significance of government-backed technological support in the country's efforts to establish a sustainable and affordable traceability system. Respondents were also asked about the reliability and accuracy of blockchain-based traceability information and how it could help make supply chain traceability systems more cost-effective.

In addition, participants in the study were questioned regarding their perspectives on the simplicity of operating blockchain traceability systems and its impacton the implementation interventions. Finally, respondents were asked if the blockchain-based traceability system will facilitate smooth communication between firms, regulatory agencies, and consumers.

Each factor's mean and standard deviation were computed, and the findings are exhibited in Table 4.11. A majority of respondents to the study agreed that if the government provided funding and resources for the development of a traceability system, its implementation would be accelerated.

The vast majority of respondents hold the opinion that technological support will make it possible for businesses to establish blockchain-based traceability systems that are efficient and cost-effective. The mean of government support for technology is 3.49, as seen in Table 4.11.Respondents to the study agreed that the implementation of cost-effective supply chain traceability systems in Somalia would benefit greatly from the integrity and legitimacy of blockchain technology. Table 4.11 shows that the integrity and authenticity of the traceability system has a mean of 3.62, which illustrates that it can encourage the development of reliable traceability systems across the country.

Participants in the study indicated that the user-friendliness and ease of operation of blockchain-based traceability systems will aid the implementation of a system of traceability across supply network. According to the data presented in Table 4, the majority of participants recognized the significance of having a user-friendly system, as indicated by the mean value of 3.45. This finding suggests that a user-friendly interface is crucial in facilitating the creation of a system of traceability. Additionally, respondents were asked if a blockchain-based traceability system would make it simple for businesses, government agencies, and customers to communicate.

According to the study's respondents, a blockchain-based traceability system will facilitate communication between customers, importers, and regulatory organizations. According to Table 4.11, the mean of simple communication between firms, regulatory bodies, and consumers is 3.99; hence, a blockchain-based traceability system will readily bring all interested parties together so that they can share information when it is required.

Table 4. 10Technology Support

Statement	N	Mean	Std. Deviation
Technology support from the government to establish traceability system	150	3.49	1.122
The integrity and authenticity of traceability information	150	3.62	1.066
Traceability system operate easily (user friendly)	150	3.91	1.170
Easy communication between firms, regulatory bodies and consumers	150	3.99	1.117

Source: Author (2022)

3.7. Governıng Rules and Regulatıons that Motıvate Fırms to Develop a Traceabılıty System

To examine the existing legislation and regulations that could facilitate the creation and application of a system of traceability within Somalia's supply network, the study conducted interviews with senior management officials from the Somali Bureau of Standards (SoBS). Established by the Somali government in 2020, the SoBS operates under the Standards and Quality Control Act Law No. 27, which was enacted in the same year.

The primary objective of the SoBS is to establish a robust quality infrastructure for Somalimetrology, accreditation, standards, and conformity assessment, with the ultimate aim of safeguarding consumers and the environment from potentially harmful products. Thus, the study sought essential information from the SoBS to gather insights into the laws, rules, and regulations governing the traceability function in Somalia.

The participants were asked a series of questions regarding different facets

associated with food traceability, including the current laws and regulations governing traceability, the implemented supply chain standards for citizen protection, the availability of policies and guidance documents supporting traceability system implementation, the level of government support for traceability initiatives, the attitude towards adopting a distributed blockchain supply chain traceability system, and the involvement of the bureau in implementing a cost-effective blockchain traceability system. Subsequently, a condensed overview of their responses will be provided in the following sections.

How do ou describe Somalia's food traceability laws and regulations?

All of the respondents were of the opinion that Somalia does not have any laws or regulations that mandate the introduction of systems of traceability in businesses that are currently operating in the country. Respondents mentioned that in accordance with Act Lr. 27, the constitution of Somalia, in the year 2020, a national standard organization known as the Somali Bureau of Standards was founded with the responsibility of supervising and administering all items coming into Somalia. However, respondents emphasized that despite the Bureau of Standards' relatively recent establishment; it already possesses the requisite capabilities to work on the development of all essential frameworks that ensure the safety of the citizens and the environment.

What are the supply chain traceability standards in place to protect consumers from harmful products?

The respondents stated that there are food and agriculture standards that encompass the full supply chain, beginning at the farm and ending with the consumer's plate. But the Somali Bureau of Standards has not yet made it a requirement to use the ISO, ARSO, or SMIIC standards that have been adopted. This is due to poor infrastructure, a lack of government enforcement, and lack of awareness of the requirements among the general public.

Has the Somali Bureau for Standardization developed policies and guidance to support enterprises in enforcing a traceability system?

The study's respondents all agreed that the Somali Bureau for Standards has not yet created any policies or guidelines requiring businesses to implement traceability systems throughout their supply chain networks. Participants confirmed, however, that

given the bureau's responsibility to safeguard individuals from dangerous items, the creation of specific policies and procedures for supply chain traceability is among its top priorities.

Does the government offer funding, equipment, training, or maintenance support to encourage enterprises to establish a traceability system in Somalia?

The study's respondents unanimously agreed that due to its financial inability to play such a role, the government of Somalia does not provide any assistance to the local businesses in their efforts to develop a supply chain traceability system, including finance, equipment investment, employee training, or system maintenance.

Do you believe that distributed system will eliminate the current obstacles in establishing supply chain traceability system?

Study participants are in complete agreement that current hurdles to tracing the sources of the incoming items in Somalia can be eliminated with the use of a distributed system of supply chain traceability. They added that a distributed system of traceability will create a better solution for any uncertainty issues in consumer protection and reduce numerous obstacles, resulting in the deployment of a cost-effective, transparent, and dependable system of traceability in the country.

What is the position of the bureau in the formation of a cost-effective blockchain system of traceability?

Respondents to the study acknowledged that the Somali Bureau of Standards will support and commit a budget to the development of a cost-effective blockchain-based traceability system framework in the country. This was supported by the fact that one of the mandates of the Bureau is to prevent any incident that can create health dangers to persons as well as the environment.

In addition, respondents were in agreement that the bureau will work to facilitate the deployment of a traceability system because such a system will encourage the growth of the businesses and increase the effectiveness of the supply chain.

Describe the pivotal success factors influencing the introduction of a system of traceability

The majority of study participants concurred that top management support is a crucial component of Somalia's ability to successfully adopt a blockchain-based

traceability system. Policymakers have also been cited as having a role to play in facilitating the rollout of traceability infrastructure by enacting the legislation and regulations necessary to compel businesses to use such systems. In addition, respondents agreed that law enforcement is animportant aspect in the deployment of a blockchainsystem of traceability in Somalia.

Participants in the study have also emphasized that initiatives to raise consumer awareness and involve stakeholders were among the crucial success factors that will help Somalia develop a cost-effective blockchain-based supply tractability system.

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

Introduction

This study assesses the existing supply chain traceability systems in Somalia, the governing rules and regulations for traceability, and the factors impacting the implementation of a cost-efficient blockchain-driven framework. The objective was to facilitate the smooth flow of information among relevant stakeholders and ensure transparency within the supply chain network. In this chapter, we offer a concise analysis of the study's findings, draw a conclusion based on the information gathered, and highlight potential real-world applications that can be derived from this research.

Discussion

Overview of the Study

In the global market of today, goods travel to the ends of the earth, where producers and consumers live on different continents. Despite this, there are apprehensions over the reliability of the products in terms of both their safety and their quality. The food industry had to confront credibility problems in the wake of food crises like BSE, mad cow disease, and dioxin in chicken feed.In addition, the effects of GM corpsin foods as well as the epidemic of campylobacter, Escherichia coli, and salmonella exacerbated worries regarding the safety as well as the quality of the food products.To enhance product safety, particularly concerning food and other commodities, the introduction and adoption of a reliable system of traceability is crucial.

This holds great significance for Somalia in particular, where a considerable segmentof domestic consumption depends on imported goods sourced externally. The country mainly relies on imports for various essential items, including foodstuffs, manufacturing commodities, gasoline, building supplies, medical supplies, and pharmaceuticals. Therefore, ensuring accurate information through an effective traceability system becomes imperative to safeguard the well-being of consumers and maintain standards within the market.

For the protection of the populace, property, animals, and environment, the government of Somalia is concerned about imported items' safety and operational

effectiveness. In the year 2020, the Standards and Quality Control Act Law No. 27 was passed, and with it came the establishment of the Somali Bureau of Standards (SBS), whose mission is to safeguard the public's health and safety. They are entrusted with the responsibility of ensuring the public's health and safety and the standard of products available to them.

Recently developed distributed ledger technology known as blockchain is seeing increasing use in a number of supply chain management contexts. Traceability solutions built on blockchain technology have the potential to overcome the inefficiencies present in traditional traceability systems. This study's objective was to assess the status of the systems of traceability, rules, and regulations that are already in place to ensure the health and safety of customers.

The study also looked at elements that could influence the creation of a traceability system based on blockchain that is both affordable and efficient.Structured data from all of the major participants has been acquired, analyzed, and evaluated. Among these key stakeholders are the Somali Bureau of Standards and small and medium-sized companies that import goods. Quantitative and qualitative data were collected from the participants using interviews and a self-administered, structured questionnaire.

The findings presented in this study rely on the data that was gathered from the Somalia Bureau of Standards and enterprises that import goods into Somalia. The data were examined using a descriptive methodology. Content analysis was used to sort out and categorize any verbal or behavioral information that needed to be classified. The gathered data were summarized and then tabled in order to make sense of them and to place emphasis on the most important messages, traits, or discoveries.

Table 4.1 shows that 83 percent of study participants completed the questionnaire, while all participants who were interviewed gave their feedback. The study received a total of 150 completed questionnaires, in addition, to interviewing participants.

Because there was a missing questionnaire, the sample size was adjusted. The acquired data was carefully cleaned up before being organized. The study utilized Cronbach's Alpha to verify the scale's reliability, and the calculations are presented in

Table 4.2. The findings indicate that the data were collected with a high degree of consistency, as indicated by Cronbach's Alpha value of 86%.

Personal Information and Business Characteristics

The overwhelming majority of participants were upper-level managers from various divisions or the organization as a whole. Based on the study's findings, 86 percent of respondents had two to 10 years of relevant work experience. In addition, 86 percent of people who responded to the survey either had a high school diploma or a college degree with more than one year of study.Table 4.3 encompasses all the respondent's data, alongside the determination of frequency and percentage distributions.

The study's findings show that just 10% of the companies were publicly traded, with the other 90% being privately held. It was discovered that the bulk of enterprises, 83%, had fewer than 100 employees altogether. Almost two-thirds of these companies bring in supplies of food and agricultural goods from foreign nations. The study's findings indicate that while there isn't an overwhelming amount of complexity in the supply chain, there are risks associated with the products or services offered by more than 40% of these companies. Understanding how well small and medium-sized businesses in Somalia are able to trace their supply chains is a primary research objective.

Traceability Systems and Somali Small and Medium Enterprises

We asked respondents to describe the current level of supply chain traceability at their organization so that we could gain a clearer picture. They were questioned concerning the level of support provided by the senior management of their companies and the position that was taken in relation to the application of a system of traceability.In addition, participants in the study were questioned about the processes they utilized when dealing with non-conforming items, contamination, and quality control as a management system component.

According to the survey respondents, there are no laws or regulations that require enterprises to establish system of traceability within their supply chain to ascertain the origins of imported commodities. The overwhelming majority of respondents admitted that they were not required to establish a traceability system by

any laws or regulations that they were subject to.The study examined top management's level of commitment to implementing supply chain traceability programs in their organizations.

In order to gain insight into whether or not company executives are prepared to support the implementation of supply chain traceability, a question was presented to respondents questioning whether or not the top management of their respective organizations sees traceability function as a strategic element. According to the respondents, the top management of businesses doing business in Somalia did not view traceability as a strategic goal. The vast majority of respondents believed that the chief executive officers or owners of the companies with whom they cooperate are normally moderately committed to the supply chain traceability function as a strategic goal.

The research looked into the practices that companies in Somalia have put in place to identify supply chain issues such as contamination, low quality, and non-conformance. Respondents were questioned about the existence of procedures to detect contaminated items and products with quality issues to get a deeper understanding about these processes and procedures.

Most respondents agreed that their firms are good at spotting supply chain management issues including contamination, quality, and non-conformance before they become big problems. Furthermore, the respondents revealed that their individual businesses take action in the event of contamination, quality, or non-conformance problems within their supply chain management.

The study examined how the management systems of the businesses enabled them to share information about quality issues, nonconformities, and contaminations that could occur in their supply chain with their partners and suppliers. In addition, respondents were asked if their organizations perform audits to determine whether or not relationships with supply chain partners should be maintained.

The respondents concurred that their companies have established clear sanctions for supply chain partners who disobey the policies and processes placed in place to find problems as quickly as possible. In addition, the vast majority of respondents mentioned that their organizations have already put in place a process for conducting audits to evaluate the quality of their relationships with supplier partners.

Factors Influencing the Implementation of a Traceability System

The study aims to understand the obstacles Somalia has in developing a blockchain system of traceability. Traceability system funding and support for cutting-edge technology were among the questions respondents were asked to consider. Respondents recognized that Somalia does not have any norms or regulations regarding traceability, which makes it difficult to develop efficient blockchain-based traceability systems across all businesses operating in the nation. The study's participants observed that the absence of a regulatory body is among the challenges to the country's adoption of a blockchain system of traceability.

The study examined how government and private sector funding interventions contribute to the creation of blockchain supply chain traceability systems in Somalia. Respondents were asked about the government's and companies' contributions to funding initiatives that help businesses implement cost-effective traceability systems within their supply networks. Participants in the survey confirmed to the fact that the provision of financing and assistance by the government will inspire the nation to institute a system of traceability.

The participants in the study came to the conclusion that investments in system management and maintenance are essential to the process of putting in place a blockchain system of traceability in Somalia that is not only user-friendly but also efficient in terms of cost. The study examined how government support for technology could influence the development of blockchain-based system of supply chain traceability in Somalia.

Participants were surveyed to determine how much of an impact government funding for technology had on the success of efforts to adopt a low-cost system of traceability in the country. The majority of those who participated in the study attested that the adoption of a system of traceability would move along more quickly if the government were to contribute funding and other resources toward its creation. The clear majority of respondents believed that firms would be able to use technology to put up effective and affordable blockchain-based traceability solutions.

Traceabılıty Laws and Regulatıons

The research analyzed the existing legal and regulatory framework in Somalia to see how it may facilitate the adoption of traceability system within the supply cain. This study conducted interviews with high-level officials at the Somali Bureau of Standards to learn more about the regulations, policies, and guidelines that regulate the traceability function in Somalia.

Respondents were asked about the current food traceability laws and regulations, the supply chain standards that are in place to protect citizens, the policies and guidance papers that support the creation of a traceability system, the government's support in introducing a system of traceability, their position on the implementation of a blockchain system of traceability, and the bureau's position on the application of a co-ordinated system of traceability.

According to the respondents, Somalia does not have any laws or regulations mandating the deployment of a system of traceability. The Bureau of Standards was only recently established, but respondents stressed that despite this, it already has the necessary skills to work on creating all crucial frameworks that guarantee public and environmental safety.

As of now, there are food and agriculture standards. However, the Somali Bureau of Standards has not yet made compliance with the adopted ISO, ARSO, or SMIIC standards mandatory. Respondents to the study acknowledged that the Somali Bureau of Standards has not yet established any regulations or guidelines mandating the implementation of traceability systems throughout supply chain networks. However, participants noted that the adoption of detailed policies and procedures for supply chain traceability is among the bureau's top goals because of its responsibility to protect people from harmful things.

Participants in the research acknowledged that the Somaligovernment lacks the resources to assist local enterprises in establishing a supply chain traceability system. In other words, the government doesn't provide assistance with funding, equipment purchases, personnel hiring or training, or system maintenance.

The study's participants are unanimous in their belief that a distributed system of supply chain traceability would be the most effective way to overcome the current obstacles to tracking the provenance of the arriving commodities in Somalia. They

also stated that a decentralized traceability system would be an improved method to address any concerns of uncertainty in consumer protection and would eliminate many barriers.

As a result, a low-cost, dependable, and transparent traceability system might be developed across the nation. According to study participants, the Somali Bureau of Standards will support and allocate funding for the national implementation of cost-effective blockchain-based traceability system architecture. This is backed by the fact that one of the missions of the Bureau is to prevent any incident that could pose a health danger to people or the environment. Additionally, respondents agreed that the bureau will ensure to enable the introduction of a system of traceability since they will promote enterprises's growth and boost their supply chain efficiency.

The majority of research participants agreed that support from the highest levels of management is essential for Somalia to successfully deploy a blockchain system of traceability. Policymakers have also been cited as having a role to play in facilitating the implementation of traceability infrastructure by passing the legislation and regulations necessary to compel firms to utilize such systems. This is because policymakers have been cited as having a role to play in facilitating the rollout of traceability infrastructure.

In addition, respondents were in agreement that the adoption of a traceability system in Somalia requires law enforcement to play a important role in the process. The study's participants have also stressed that attempts to increase customer awareness and involve stakeholders are among the essential success criteria that will aid Somalia in creating a cost-effective blockchain-based supply chain traceability system.

Conclusion

The global nature of today's market has made it much simpler for goods to be transported between different countries. Among the goods that are most frequently transported from their place of production to another continent for consumption are foodstuffs. Concerns about the reliability and security of these devices are progressively developing. Following multiple accidents involving food safety, traceability become increasingly important, especially in the food production and distribution network.

In the context of the western world, the application of a system of traceability that can provide accurate information has resulted an increase in the overall level of consumer protection, particularly with regard to foods and other commodities. Domestic consumption in Somalia is primarily reliant on foreign imports of goods. Somalia brought in $4.2 billion worth of goods in 2020. The Somali Bureau of Standards (SoBS) was founded in 2020 under the Standards and Quality Control Act Law No. 27 to address the anticipated safety and quality problems regarding the imported products. On the other hand, Somalia is lacking in both the infrastructure and the regulations that are necessary to ensure that imported goods are safe.

This study aimed to get insights into about the current status of Somalia's traceability systems, examining the regulatory landscape governing traceability, and exploring the driving factors behind the adoption of a cost-effective blockchain-based framework for enhancing communication among stakeholders and ensuring transparency within the supply chain. To carry out this research, comprehensive data was gathered, analyzed, and evaluated from various significant participants. Key stakeholders such as the Somali Bureau of Standards and small and medium-sized businesses involved in importing goods were particularly included in this research effort.

In order to examine the factors that have an effect on the development of a blockchain system of traceability at a lower cost, a mixed-mode technique has been utilized. Face-to-face interviews and written questionnaires based on a five-point Likert scale served as the means of data collection for this study.

Questionnaire was administered to the firms who bring goods into Somalia from other countries. Interviews have been performed with the Somali Bureau of Standards'

administration to collect the required information. The descriptive statistics we use, like as the mean, the frequency distribution, and the standard deviation, allow us to compare the performance of different subsets of the sample units across our independent variables of interest.

The data from the questionnaire were first organized and then coded before being recoded into a computer using SPSS. While taking notes, the researcher inquired participants of study questions of open-ended format. For the purpose of sorting and classifying any verbal or behavioral information that needed to be sorted, content analysis was utilized. The collected data were summarized and tabulated in order to make sense of it all and emphasize the most essential messages, characteristics, or discoveries.

The majority of the respondents were either department heads or other high-ranking administrators within the company. According to the study's findings, men made up 90% of the respondents. This may indicate that men hold the majority of executive positions in Somalia's small and medium-sized businesses.As per the study's findings, just 10% of the companies were publicly traded, with the remaining 90% being privately owned.

Evidence like this strongly suggests that private individuals or families own the majority of Somalia's SMEs. The majority of enterprises, 83 percent, were discovered to have fewer than 100 employees. Almost two-thirds of these firms import food and agricultural goods from foreign countries. This is just another piece of evidence suggesting that Somalia's internal consumption is reliant on things brought into the country from outside the nation. According to the study's results, the supply chain is not too complicated, but more than 40% of these companies face product or service risks.

Businesses operating in Somalia have created functional supply chain traceability systems, according to the study's respondents. Participants concur that companies are concerned about supply chain traceability issues because they are viewed as a way to protect brands and increase consumer satisfaction.

However, respondents admitted that they were no pressures from the government to set up a traceability system. According to study participants, the top management of their individual organizations does not consider supply chain traceability as a

competitive environment. Respondents also state that their companies are adept at spotting difficulties with supply chain management, such as those involving contamination, quality, or non-conformance, at an early stage. In order to improve quality, reduce contamination rates, and implement non-conformance programs, there is some sort of collaboration between the firms and their supply partners.

The study reveals that Somalia does not have any norms or regulations regarding traceability, which do not pressurize firms create a supply chain traceability system. This makes it difficult to develop efficient blockchain-based traceability systems across all businesses operating in the nation. Furthermore, results show that a lack of traceability standards hinders the deployment of an effective system of traceability in Somalia. Participants in the study said that the lack of a regulatory agency is one of the things that makes it hard to set up a blockchain system of traceability in the country.

According to the respondents, allocation of a specific budget for investing in the system is one of the elements that helps Somalia implement a blockchain-based traceability system. A factor that might favorably influence the adoption of a blockchain system of traceability in the nationis customers' willingness to buy things that can be traced as per the argument of the respondents. The majority of respondents believe that technology support will enable firms to develop efficient and cost-effective blockchain-based traceability systems.

Participants believe that the user-friendliness and ease of operation of blockchain-based traceability solutions will help establish an effective supply chain traceability system. The research examined Somalia's existing laws and regulations to see whether they may aid in the introduction of a traceability system. The top management of the Somali Bureau of Standards was interviewed for the purpose of this research so that relevant information on the laws, rules, and regulations that regulate the traceability function in Somalia could be gathered.

According to the respondents, there are neither rules nor regulations in Somalia that require nor encourage the establishment of a system of traceability by companies already doing business there. The Bureau of Standards was just recently established, but respondents stressed that despite this, it already has the necessary skills to work on creating the crucial frameworks that guarantee public and environmental safety. The

respondents acknowledged the existence of food and agricultural standards but noted that the Somali Bureau of Standards has not yet made their usage mandatory.

There are currently no laws or regulations mandating that companies implement traceability systems across their supply chain networks from the Somali Bureau for Standards. Respondents concurred that, owing to its financial incapacity to play such a role, the Somalian government does not provide assistance to local firms in their attempts to build a supply chain traceability system. Respondents are optimistic that a decentralized blockchain-backed framework would aid the creation of an effective, reliable, and transparent traceability system in the nation and provide a better solution to any uncertainty concerns in consumer protection.

The participants in the study indicate that the Somali Bureau of Standards would support and devote a budget to the development of a cost-effective system of traceability built on blockchain technology. Introduction of a blockchainsystem of traceability in Somalia relies heavily on the backing of top management. Policymakers have also been noted as having a big role in enabling the establishment of traceability infrastructure by passing the laws and regulations required to force companies to utilize such systems.

In addition, respondents agreed that implementing a blockchain-based system of supply chain traceability in Somalia requires strong law enforcement. Participants in the research have also noted that attempts to increase consumer awareness and engage stakeholders are among the critical success factors that will help Somalia establish blockchain-based supply chain traceability system.

Recommendations

The global economy is becoming more globalized, and supply chains are becoming more complicated as a result. A wide variety of goods and a wide variety of providers serve clients located in various regions of the globe. This raises additional difficulties in terms of the safety and transparency of the items being consumed. Domestic consumption in Somalia is mostly reliant on goods brought into the nation from other parts of the world. For instance, Somalia imported $4.2B in 2020.

Foods, construction materials, gasoline, medicines, electronics, and manufactured goods are the most common items imported to Somalia. India, Turkey, Pakistan, China,

Egypt, Oman, and the United Arab Emirates make up the sources of these products. It is often necessary to pay additional attention and care to ensure the safety of items that have been imported. Therefore, the Somali Bureau of Standards was founded in 2020 by the Somali government in accordance with Law No. 27 of the Standards and Quality Control Act (SoBS).

The Somali Bureau of Standards was established with the primary purpose of putting in place a reliable quality infrastructure for the country of Somalia (standards, metrology, accreditation, and conformity assessment). It is abundantly evident that supply chain traceability is no longer an option; this is true not just from a legal point of view, but also as a method of brand protection and as a source of comfort for the customer. The study's conclusions acknowledged that Somalia lacks traceability standards or laws, which makes it challenging to create effective blockchain-based traceability systems for all enterprises operating in the country.

Policymakers should adopt the required rules and regulations that control traceability of the supply to ensure the well-being of society and the environment. This would be the best way to protect both. Moreover, this will compel businesses importing goods like food and agricultural goods to set up traceability systems that recognize, monitor, and trace components of such goods. The study's findings indicate that a major obstacle to the widespread formation of a system of traceability in Somalia is the absence of standards. As a result, the Somali Bureau of Standards needs to formulate relevant requirements and stipulate that these standards have to be satisfied prior to the production or importation of goods.

The study's conclusions indicate that no regulatory body is in charge of ensuring that traceability laws and requirements are being followed. To protect the well-being of the consumers and ensure compliance with applicable laws and rules, the Somali Bureau of Standards ought to establish a department dedicated to this function. Small and medium-sized firms (often known as SMEs) that do business in nations afflicted by violence, such as Somalia, confront a variety of complicated and one-of-a-kind obstacles.

The Somali Bureau of Standards would fund and promote the creation of a blockchain system of traceability in the country. Businesses also perceive that the ease of use and straightforward operation of traceability solutions built on blockchain technology would facilitate the formation of an effective system of traceability.

Utilizing digital technology may result in a multitude of positive outcomes. In terms of food safety, it may significantly minimize the time required to determine the source of contaminated products.

The bureau should concentrate on creating a decentralized blockchain system of traceability where enterprises will have access to record all pertinent supply chain data, consumers will provide comments and events they encounter while consuming goods, and the regulatory agency will monitor and manage the well-being and transparency of the supply network.

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APPENDIX 1: DATA COLLECTION TOOL – COVER LETTER

Dear Participants,

I cordially invite you to take part in a research project investigating the implementation of a blockchain-based supply chain traceability framework in Somalia. The primary objective of this study is to analyze existing supply chain traceability systems, regulatory frameworks governing traceability, and the factors influencing the adoption of a cost-effective blockchain-based solution. Enclosed with this letter is a concise questionnaire, which we kindly request you to carefully review and provide accurate responses.

Please note that completing the questionnaire should take no longer than 10 minutes of your valuable time. The insights obtained from this study will significantly contribute to the development of an efficient supply chain traceability system in Somalia. Rest assured that your identity will remain completely anonymous. We sincerely appreciate your voluntary participation and kindly urge you to complete the questionnaire and return it as promptly as possible.

If you are interested in knowing the research findings or have any questions or concerns regarding this study, please do not hesitate to contact us via email at

Thank you for your invaluable contribution.

Regards

Abdikarim Mohaidin Ahmed

APPENDIX 1: DATA COLLECTION TOOL – QUESTIONNAIRE

Section one

Personal Information

Gender:

- M
- F

Current position:

- Manager General
- Head of Department
- Manager of Project
- System Operator
- Others (Please fill positions on the line) _____

Experience

- 1 year
- 2-5 years
- 5-10 years
- over 10 years

Education background

- High School
- College
- Undergraduate
- Postgraduate

Section two

The characteristics of the respondents(business firms)

Firm Ownership	
Public	
Private	
Employees	
Below 100	
Above 100	

Commodities	
Raw Material	
Food Products	
Agricultural Products	
Construction Materials	
Product/Service Risk	
High	
Low	
Complexity	
High	
Medium	
Low	

Section Three

To what extent do the Somali small and medium enterprises trace their supply chain network?

Statement	SDA	DA	N	A	SA
1. Current Status					
We have established a functioning supply chain traceability system within our organization					
Supply Chain Traceability is given s major concern in our firm and is seen as vital function for brand protection and customer satisfaction					
There are governing rules and regulations that forces organizations to establish supply chain tractability system					
Customers tend to demand complain response and product recalls when quality issues arise					
Our organization has implemented robust protocols and procedures to address supply chain contamination, ensure product quality, and effectively manage non-conformance issues.					

2. **Top management support**					
Traceability is regarded as a strategic priority by the leadership					
The top management allocated a budget for supply network traceability					
The top management recognizes traceability as a key driver of competitiveness					
3. **NonconformingProcesses/Procedures**					
Identify instances of contamination, quality deficiencies, or non-conformances within our supply chain.					
Responses are initiated to rectify a contamination, quality issue, or non-conformance event occurring in our supply chain.					
An established recovery process is enacted subsequent to a quality issue, non-compliance, or contamination event within our supply chain					
4. **ManagementSystem**					
Enforces penalties for partners who disregard the prescribed procedures and guidelines regarding standards, contamination, or compliances					
Mandates that our partners share with us necessary and relevant data that enables our company to effectively address and manage an incident involving contamination, quality issues, or non-conformance.					
Promptly delivers appropriate data to our supply chain partners in order to effectively respond to an incident involving contamination, quality deficiencies, or non-conformance issues.					
Promptly engage in effective communication with supply chain partners to address cases of contamination, quality issues, or non-conformance					
Collaborate with partners in improving their quality, contamination, and compliance programs					

Utilizes audits as a means of assessing whether to sustain collaborations with supply chain partners.					

Section Four

What are the factors affecting the implementation of a cost-effective blockchain-based traceability system

Statement	SDA	DA	N	A	SA
Regulation					
Absence of traceability laws and regulations					
Absence of traceability standards					
Absence of policy guide for implementing traceability systems					
Absence of regulatory bodies					
Investment					
Government Funding for traceability system implementation					
Cooperate budget for investment in traceability system					
System operation and maintenance investment					
Consumer willingness to pay for traceable food					
Technology					
Technology support from the government to establish traceability system					
The integrity and authenticity of traceability information					
Traceability system operate easily (user friendly)					
Easy communication between firms, regulatory bodies and consumers					

END

APPENDIX 2: DATA COLLECTION TOOL – INTERVIEW QUESTIONS

Governing rules and regulations that motivate firms to develop traceability system

Interviewee:_____

Position:_____

Work Experience:

_____

Interview Date:

_____

1. How do you describe Somalia's food traceability laws and regulations?
2. What are the supply chain traceability standards in place to protect consumers from harmful products?
3. Has the Somali Bureau for Standardization developed policies and guidance to support enterprises in enforcing a traceability system?
4. Does the government offer any of the following support to encourage enterprises establish traceability systems:
    a. Funding support for supply chain traceability system implementation
    b. Equipment Investment
    c. Training employees
    d. System maintenance
    e. System operation and maintenance investment
5. Do you believe that distributed system will eliminate the current obstacles in establishing supply chain traceability system?
6. What is the position of the bureau in the formation of a cost-effective blockchain system of traceability?
7. Describe the pivotal success factors influencing the introduction of a system of traceability.

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RESUME

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Publications:

1. Supply Chain Vulnerability Management Practices in Somalia, World research library, 2018
2. The Role of Social Networks on Building Organizational Strategic Partners - The Case of Somali Private Banks, Proceedings of the 16 International Strategic Management, 2021.
3. An Empirical Study on the Factors Influencing the Implementation of Blockchain-Based Supply Chain Traceability System in Somalia, Journal of Logistics, Informatics and Service Science, 2023.
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5. Factors Influencing the Adoption of Green Supply Chain Management: A Comprehensive Empirical Study on Pressures and Practices, Journal of Logistics, Informatics and Service Science, 2023.

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