PERCEPTION OF PROCUREMENT PROFESSIONALS ON THE ADOPTION OF BLOCKCHAIN TECHNOLOGIES AND ITS IMPACT ON SUPPLY CHAIN MANAGEMENT IN KENYA

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DECLARATION

I, the undersigned, declare that this is my original work and has not been presented to any institution or university other than the University of Nairobi for examination.

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This Research Project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

Project specially dedicated to my parents Mr. and Mrs. Kamau and family especially my brother Peter who supported me financially and emotionally throughout the research period. Thank you for putting up with my absence in crucial family moments.

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ABSTRACT

The objective was to explore perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. Specific objectives included to establish the extent of adoption of blockchain technologies in supply chain management, to determine the relationship between blockchain technologies and total efficiency in supply chain management, and to explore opportunities of blockchain technologies in supply chain management.

The study was designed as exploratory research. By use of a questionnaire, data was collected from a total of 210 respondents. Descriptive statistics and ordinal regression analysis were the conducted for data analysis in SPSS.

The study found that there was limited awareness of the current attempts to apply blockchain technologies in supply chain management. The fact that blockchain is more popular for cryptocurrencies may have affected the awareness of the participants about supply chain applications of the technology. The study also found a strong positive relationship between cost efficiency, provenance, traceability, time efficiency, and order fulfilment as independent variables, and total supply chain efficiency as the dependent variable. Ordinal regression recorded a Cox and Snell R-square of 0.935 indicating that a strong relationship existed between the factors of the research and total supply chain efficiency.

Lastly, the research established that improved traceability would be the greatest opportunity for the application of blockchain technologies in supply chain management. Substantial improvements would also be recorded in all other aspects of supply chain management including the areas of provenance, cost efficiency, time efficiency, and order fulfilment. In concluding the study affirmed high potential for the application of blockchain technologies in supply chain management.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DOI   Diffusion of Innovation

EU   European Union

KISM Kenya Institute of Supply Chain Managers

OLS   Ordinary Least Squares

RFID   Radio Frequency Identification Tags

SCM   Supply Chain Management

SCOT Social Construction of Technology

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Every single item consumed comes with a story about journeys of people, places, and materials. However, these stories often remain obscured by marketing information about the products, yet the stories are at times horrific and outright unethical (Steiner, 2015). The reasons why such stories would be masked is the complex nature of global supply chains through which many physical consumables pass. At the same time, provenance and traceability in global supply chains has remained downright primitive as consumers can still not trace inputs to a production process. These supply chain problems have led to the burning question of whether there is any viable and effective solution to the supply chain management (SCM) problems (Pilkington, 2016).

Consumer awareness on SCM, centrally involving product authenticity and ethical standards, has been on the rise. Consumers are increasingly demanding genuine transparency on where and how the products they consume are made. Regulators and consumer watchdogs across the world have taken the cue with the European Union (EU) creating regulations requiring manufacturers to publish more information about their supply chain systems and, there was adequate punishment for manufacturers who fail to do so (Steiner, 2015).

While there are regulations already coming up and the supply chain managers attempting to provide additional information about products and supply chains, genuine transparency has proven difficult (Pilkington, 2016). Current technologies such as radio-frequency identification tags (RFID) are only able to provided limited information and about supply chains. This research argues that the RFID technologies are not powered to deal ensure provenance and traceability of products from the point production, to use in manufacturing processes, and to the final product (Crosby, Pattanayak, Verma & Kalyanaraman, 2016).

Product traceability is not the only problem that needs a solution in SCM. Concerns of trustworthy relationships among various stakeholders in SCM is a major issue. An importer in Kenya does not fully trust a seller in another country to ship products as per the description in the importation documentation and the seller does not fully trust that if they ship a product they will get paid. This creates the need for far-reaching disruptions in the supply chain to ensure provenance and traceability.

The problems facing the SCM industry require a disruptive trustless solution (Anjum, Sporny & Sill, 2017). This research proposes that blockchain technology could be the technology that will effectively deal with all the problems facing supply chain management especially with respect to the challenges of provenance, traceability, and ethical standards.

1.1.1 Blockchain Technologies

Blockchain technology refers to a decentralized shared ledger where a network of peers maintain copies of one truthful ledger (Nakamoto, 2008). The technology was first proposed by Nakamoto (2008). As the title of the white paper indicated, the blockchain technology started as a technology designed to streamline online payments by eliminating the problem of double-spend (Nakamoto, 2008).

Blockchain is a trustless technology meaning that participants in the supply chain no longer need engage in business based on trust (Crosby, Pattanayak, Verma & Kalyanaraman, 2016). Rather, the technology replaces trust with consensus generated by miners on the state of the distributed ledger and cryptographic security features (Condos, Sorrell & Donegan, 2016). The fact that blockchain technology is a decentralized technology means that there is no limit as to the number of participants that here can be in the supply chain and as the number of participants increases, the hashes increase and the computing power needed to carry out attacks on the system becomes increasingly high. As this power goes high the risk of attacks such as Sybil or 51% attack, as described Satoshi Nakamoto, become a distant possibility (Nakamoto, 2008).

Blockchain technology, as a source of total supply chain efficiency, is important in eliminating the dependence on trust-based business interactions. A supply chain management system built on blockchain technology would reflect performance of the supply chain at every stage. This would result in overall efficiency.

1.1.2 Supply Chain Management

Supply chain management refers to the management of the movement of goods and services from the producers to final consumers. In this process, supply chain management aims at creating and maximizing value for the producers and the consumers while at the same time enabling the producers to attain sustainable competitive advantage.

Supply chain management is essential in an increasingly connected world where a single product would have raw materials from multiple across the world. It is a process that involves

multiple parties and where multiple parties form halfway across the globe exists, lacking trust is common problem (Upadhyaya, Sharma & Arun, 2017). The lack of trust among players in the supply chain management industry has led to the considerations of what the future of global supply chain management would look like.

In relation to total blockchain technologies, supply chain management would improve by eliminating the dark areas of supply chain management where the supply chain managers lack certainty about the status of transactions and goods especially because they fully depend on trust. Implementation of blockchain technologies has the potential of revolutionizing how business persons interact with the supply chain management system.

1.1.3 Supply Chain Management in Kenya

Kenya's economy is increasingly dependent on international trade hence high dependence on supply chain management. The many traders in Kenya who are dependent on the supply chain efficiency face the problems of traceability, provenance, cost efficiency, time efficiency, and order fulfilment challenges that are common to supply chain management globally. An importer in Kenya does not fully trust a seller in another country to ship products as per the description in the importation documentation and the seller does not fully trust that if they ship a product they will get paid. The need for a shift from a trust-based supply chain system to a trustless supply chain system is therefore long overdue (Belfrics, 2018).

Kenya is a gateway to the landlocked countries in East Africa including Uganda, South Sudan, Rwanda, and Burundi. Creating an efficient supply chain management system does not only affect Kenyan traders but also the trader in the rest of the East African countries as well as Central African countries that prefer using the robust Kenya transport network. Creating an efficient supply chain management system would actually be a spring of competitive advantage (Belfrics, 2018).

1.2 Statement of the Problem

The application of blockchain decentralized technologies has been proposed by various researchers as a possible solution to the challenges facing SCM. However, there has not been adequate research focusing on the adoption and use of blockchain technologies in SCM (Condos, Sorrell & Donegan, 2016). Partly, the inadequacy of research on supply chain applications of blockchain technologies is because the technology is fairly new, having been

introduced first in 2008 (Nakamoto, 2008). Partly, the inadequate research is a result of so much focus on cryptocurrency applications of blockchain technology leading to the overshadowing of other possible applications of blockchain technology such as its applications in supply chain management (Condos, Sorrell & Donegan, 2016).

Apart from inadequate research, the very fact that blockchain technologies have been indicated to be a possible solution for the SCM industry makes it essential to observe whether the industry is looking into the possibilities of using blockchain technologies to manage supply chains (Crosby, Pattanayak, Verma & Kalyanaraman, 2016). The study delved into the questions of the extent to which supply chain managers are considering the adoption of blockchain technology.

Lastly, SCM is particularly important for Kenya for a variety of reasons. Firstly, Kenya's economy is increasingly dependent on international trade hence high dependence on supply chain management. Secondly, Kenya is among the early adopters of technology in Africa with other countries in the same category including Nigeria, South Africa, and Egypt. In the recent there has been news on cryptocurrencies being accepted in parts of the country including possible applications in supply chain management. This makes it important to study and understand the possibilities and opportunities that blockchain technologies could offer the country (Belfrics, 2018).

Overall, there is a wide knowledge gap on the applications of blockchain technologies in SCM. The study seeks to add to the body of information on supply chain applications of blockchain technologies

1.3 Research Objectives

The general objective of the research is to perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. In order to meet the general research objective, the study must meet the following specific research objectives.

The specific objectives include:

    i. To establish the extent of adoption of blockchain technologies in supply chain management.

ii.To determine the relationship between blockchain technologies and total efficiency in supply chain management.

iii.To explore opportunities of blockchain technologies in supply chain management.

1.4 Value of the Study

The study creates value for supply chain managers, researchers, and policy makers.

Supply chain management is currently characterized by centralized systems (Tar, Rudas, Bitó, & Machado, 2005). Relationships among the supply chain participants are anchored on trust which fails often. Additionally, the current systems result in primitive traceability and provenance. The implications are that finding viable applications of blockchain technologies in SCM would change the order of operations in SCM. The roles and responsibilities of supply chain manager would be redefined.

To research and academia, this research contributes to a growing body of information on advancing the uses of blockchain technologies beyond cryptocurrency applications. By virtue of using primary data the research ties theoretical information about blockchain technologies with practical applications especially in supply chain management. As part of a wider body of knowledge on blockchain technology the research focuses on narrowing the gap on the understanding of the various applications of blockchain technology (Belfrics, 2018).

Lastly, policy makers would be interested in understanding the applications of blockchain technology in SCM to inform policies on supply chain management and logistics. Various processes of interest to the regulators and policy makers would be critical especially when considering global supply chains. For instance, it may be necessary for the policy makers to understand what their role would be in enabling the successful implementation of blockchain technologies in supply chain management. The perspective is particularly important considering that legal acceptance of some blockchain applications especially in cryptocurrencies have been met by intense opposition from regulators.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Chapter Two focuses on literature review. Under the theoretical review of literature, the study focused on diffusion of innovation theory (DOI) and social construction of technology theory (SCOT).

2.2 Theoretical Review of Literature

This section focuses on diffusion of innovation theory (DOI) and social construction of technology theory (SCOT).

2.2.1 Diffusion of Innovation Theory

The Global Innovation Index 2018 ranked Kenya at position 78 on the list of the most innovative countries across the world. In Africa, Kenya ranked third after South Africa and Mauritius. In the business sophistication innovation input sub-index Kenya was ranked 49th while in the creative outputs innovation output sub-index Kenya was ranked 56th. Such are the statistics that prove Kenya as a nation of innovators and early adopters of technology, on the scale of Rogers (1962) diffusion of innovation theory.

The diffusion of innovation theory (DOI) explains how, over time, an idea or a product gains acceptance. DOI appreciates that the adoption of a new idea does not happen simultaneously in a social system. Rather, adoption is a process in which some people are more apt to adopt the innovation that others. Rogers (1962) established that people who adopt technologies early are characteristically different from late adopters. On this premise the theorist established that there are five adopter categories. Innovators are venturesome and take interest in new ideas while the early adopters recognize the need to change and are comfortable in adopting new ideas. The early majority adopt new ideas before the average person who is in the late majority. Characteristically, the late majority adopts a new idea after it has been adopted by a majority. The last category are the laggards who are the hardest group to bring on board (Rogers, 1962).

This research submits that the adoption of blockchain technologies in supply chain management in Kenya will, to a great extent, depend on the diffusion of innovation ranking of the decision makers in supply management. Using prompts targeted to the identification of the ranking of the respondents, the research will provide a predictive model on the possibility of adoption of blockchain technologies in SCM in Kenya.

2.2.2 Social Construction of Technology Theory

Closely related to the diffusion of technology theory is the Social Construction of Technology Theory (SCOT). SCOT posits that technology does not define human action. Instead, human action shapes technology. In this research, SCOT requires looking into the social failures that create the need for technologies.

Blockchain technology is a trustless technology meaning that transactions will no longer depend on trust-based relationships. In supply chain management, broken trust results in cost, provenance, and traceability problems that are making innovators to look elsewhere to solve the problems. This has been the basis of forming companies and products such as Provenance®, Everledger®, Skuchain®, and Blockverify® among many other attempts at applying blockchain technologies in SCM.

One of the concerns for the research is the potential for acceptability or rejection of blockchain technologies in SCM. In the recent past Kenya experienced resistance to the digitization of land records using blockchain technologies and the challenge was that such resistance came from the industry players. It would be important to determine whether for any reason the supply chain managers would reject blockchain technologies application in the industry.

2.3 Blockchain Technology

Blockchain technology started as a technology designed to streamline online payments by eliminating the problem of double-spend. Double-spend refers to a flaw in payment system which results in a user spending a currency more than once. In the context of contracts, it would entail using the same contract more than once such there are two legal claimants to the same smart contract (Nakamoto, 2008). Research demonstrates that while financial transactions may be real-time, the problem of double-spend exists especially if the user is fast enough to enter two transactions almost simultaneously (Anjum, Sporny & Sill, 2017).

Blockchain technology has been strongly associated more with online payments due to the use of Bitcoin as the first technology making the use of blockchain technology. Other products include smart contracts that built on the Ethereum blockchain technology (Buterin, 2016). In essence there is huge potential with the applications of blockchain technology, most of which continue being discovered as governments and business entities such as the banking sector supporting research into the applications of blockchain technology (Roriz & Pereira, 2018).

Supply chain management is one of the areas that may be heavily impacted by the application of blockchain technology (Anjum, Sporny & Sill, 2017). Researchers have already started focusing on the possible applications of blockchain technology in supply chain management though there is no adequate evidence that the technologies have started being used in supply chain management. This researcher seeks to contribute to ongoing research on the applications of blockchain technologies in supply chain management.

The interest in blockchain technology emanates from the understanding of the possibility of a nexus between the problems faced in supply chain management and the properties of blockchain technology (Nakamoto, 2008). One of the key tenets of blockchain technologies is helping in resolving trust problems by the use of a decentralized ledger and peer to per proof of work and proof of ownership (Mougayar, 2016). As designed, the technology eliminates the need for unscrupulous middlemen and in their place are nodes called miners whose role and responsibility if to conduct proof or work and proof of ownership through mining. As Satoshi Nakamoto noted, the peer to peer model is designed such that it prevents any possibility of a Sybil attack. To conduct a Sybil attack the users need to have control or collaboration with more than 51% of the miners in the network which is why the attack may also be referred to as the 51% attack. Attaining the attack on a network such as Bitcoin would require control over majority of the computing power of Bitcoin. Getting such control is not only impossible but also expensive making the possibility of such an attack remote (Nakamoto, 2008).

The other property of blockchain technology that makes it an attractive solution to supply chain management problems is the inalterability of records. Once created, a smart contract build on blockchain technology can neither be altered nor deleted (Nakamoto, 2008). However, the holders of the smart contract can trade in it and with every trade a timestamp is established (Buterin, 2016). The implications are that miners are able to prove whether or not a particular contract exists and if it does, ensuring that a recorded history of the contract exists. Changes in ownership are accompanied by timestamps. the overall impact is not just in the traceability of the records but also in the ensuring that issues such as double-spend in supply chain are avoided. If a product is protected by blockchain technology then it means that no other party other than the owner can transact in the product. Once they transact the history of the transactions was preserved in continuous chains and they can no longer transact in the same product. In such an approach the technology would ensure that test is restored to the supply

chain system and that so long as transactions are protected with blockchain technology the traders and participants in the supply chain system would not need to worry about trust (Mougayar, 2016).

Successful application blockchain technology in supply chain management would only be influenced by trust only to the extent that organizations and participants in supply chain management agree to decentralize the sharing of information about products in the supply chain system. This includes information on the source of a product, the description of the product, tested quality of the product, shipping information, and use of the product in a manufacturing process. Through such sharing of information the consumer would be able to track and trace a product from source to the point of consumption, the traders would be able to trace the product from the producer to the final retailer, and manufacturers would be able to give detailed information about a product. In other words, the application of the technology would provide a solution to the problem of traceability and provenance by eliminating primitive traceability. At the same time, the technology would resolve the problems with cost, quality, and time as the traders do not need to travel halfway across the world while they can dependably place order online and expect to get goods as per the actual description.

While blockchain technology is considered as possible solution to supply chain management problems, there has not been any significant research on blockchain technology in Kenya. However, in the recent pas there has been the entry of firms seeking to streamline supply chain through blockchain technology. It is such endeavors that motivate the conducting of research on blockchain technology and supply chain management.

2.4 Supply Chain Management

The study submits that that the future of supply chain management lies in solving the current problems of SCM using technologies such as blockchain and decentralized applications. The convergence between these strategies would help supply chain managers in dealing with the common problems in supply chain management. The problems broadly include cost, speed and quality.

Over the years, there has been increased consumer awareness of the processes of supply chain management. The consumers are quickly shifting from blind purchases of goods which do not provide details of origin of the product and the inputs used, and awareness of the production

processes including the treatment of the people providing labor for the production of the goods and services As the awareness heightens, manufacturers are forced to consider not only the cost and quality of their products but also the social and environmental implications of their goods.

The need to know how and where goods and services are sourced is defined as the problem of traceability and provenance in supply chain management (Steiner, 2015). Traceability focuses on ensuring that the consumer is able to determine the source of a product while provenance deals with the quality assurance by demonstrable provision of traceable inputs to a production process. These challenges in supply chain management call for new and disruptive solutions.

Traceability and provenance are not only challenges for the consumers. Traders and business persons are as much interested in the two challenges as the consumers (Steiner, 2015). The lack of adequate trust in supply chain arties across the world has resulted in many traders finding cost-efficient methods of tracing products from a source in China, through the shipment period to a port in Kenya. On many occasions, small traders are forced to physically travel to other parts of the world to personally source goods, ensure that the goods are delivered to a port of exit and then fly back to the country why they have to wait for their goods to be delivered. In the entire process many business persons are not able to trust that the goods was delivered in the quality, quantity, and time agreed on with the suppliers and other players in the supply chain management system. As a matter of fact, many traders have had to deal with the challenge of paying for goods that were never delivered, goods that were of different description from what was ordered, and goods that were of different quality form what the purchase orders and shipping documents provided. These challenges have remained a major concern in supply chain management hence the focus this research on the problems.

The supply chain management problems associated with cost, time, quality, traceability, and provenance are not an isolated problem for Kenya. Rather, these are problems facing supply chain management across the world. If it is not issues of costs being arbitrarily inflated by some traders in the supply chain, then it is a problem with primitive traceability that makes it difficult to determine what inputs went into a production process. These problems are all linked to the existing centralized technologies that suffer isolated data storage. A producer in China is not able to share information with a manufacturer in Kenya in a decentralized manner and

both are not able to share information with end consumers of the final product after it has used inputs from different sources. Similarly, these parties are not able to share information with logistics companies that will ship the product to the final consumer. As a result, the consumers are only able to access information provided to the by parties that last packaged a particular product. While this description does not provided an exhaustive perspective into the problems facing supply chain management, it leads to the consideration of what if there was a technology solution to all or most of the challenges facing supply chain management.

2.5 Impact of Blockchain Technology in Supply Chain Management

There are global efforts towards the application of blockchain technologies in supply chain management. According to Upadhyaya, Sharma and Arun (2017) a popular start up known as Blockverify has started to provide a blockchain-technology-based solution to track products along the supply chain. Weldon, Ghosh and Herridge (2016) indicated that besides Blockverify, there are other early solution tests for the application of blockchain technologies in supply chain management. Everledger, utilizes a permanent ledger for transaction history. The application is targeted to insurance companies, owners, claimants and law enforcement. Another UK-based company called Provenance is using blockchain to build trust in SCM (Weldon, Ghosh & Herridge, 2016). Such endeavors are early indicators of blockchain technologies being used to solve problems in supply chain management.

2.6 Opportunities of Blockchain Technologies in Supply Chain Management

In August, 2018 a company named TMX Blockchain Logistics announced its venture in Kenya's cargo logistics business. The aim of the business is to use blockchain technologies to enhance open, transparent, open, and democratic process through decentralized systems where all participants in the logistics business can communicate with each other in an open platform. In the pitch, the CEO of the company stated that many issues have been discussed around the export trading system in Kenya with respect to how it inconveniences buyers and sellers of commodities, causes high supply chain costs, and results in hiking of prices to the value chain. To solve all such problems in supply chain management TMX offers a system to order and track goods online. The blockchain bases technology enables the buyers to know the amount of money required throughout the different processes the cargo goes through as well as the estimated amount of time (Capital Business, 2018).

Another company called Belfrics Global launched its operations in Nairobi. The company seeks to open blockchain exchanges in Africa. The leadership of the company asserted that though there has not been adequate discussions on blockchain applications in agriculture, the technology offered unique opportunities for the agricultural supply chain as people globally seek to consume healthy foods. The need to track the food from the table to crop fields. The company reiterated that supply chain tracking in agriculture is one of the many potential applications of blockchain technologies (Belfrics, 2018).

The above examples are just examples of the huge opportunity that exists in the applications of blockchain technologies in supply chain management. Innovations and early adoption of the technologies in Kenya is evidence enough that the industry is ready for major disruptions that would potentially redefine total efficiency in supply chain management. However, the buck lies with the decision makers in the supply chain management industry.

2.7 Conceptual Framework

The conceptual framework represents the relationship between the independent, intervening, and dependent variables. Traceability, provenance, cost efficiency, order fulfilment, and time efficiency are independent variables and they impact on total supply chain efficiency. From this relationship, a conceptual framework is developed as illustrated below;

Independent variable

- Traceability
- Provenance
- Cost efficiency
- Order fulfilment
- Time efficiency

Intervening Variable

- Adoption of Blockchain applications in Supply Chain Management

Dependent Variable

- Total Supply Chain Efficiency
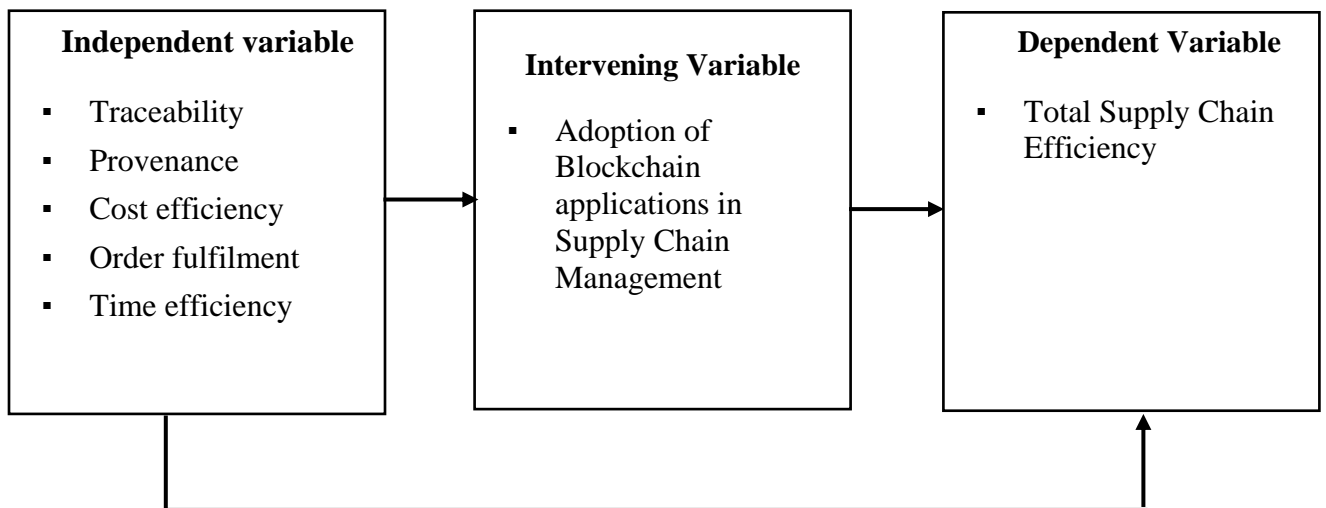
FIGURE 1: CONCEPTUAL FRAMEWORK

2.8 Chapter Summary

The research objective is to explore perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. Chapter Two of the study provides the review of literature. The chapter covers information on challenges facing supply chain management and the extent to which current technologies have been applied to solve these challenges. It also includes information on blockchain applications in supply chain management and the extent to which the technology may be able to respond to the rising needs and problems in supply chain management. The last section covers the challenges facing blockchain technology and the adoption of blockchain technologies in supply chain management in Kenya.

Across the globe there are efforts to advance blockchain technologies in supply chain management including applications in Blockverify®, Provenance®, and Everledger® among others. The review of literature identified gaps in the understanding of block chain technologies and its applications. There are also considerations on regulatory and technology diffusion challenges facing the adoption of blockchain technologies.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The research objective is to explore perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. Chapter Three of the study provides the study methodology. The chapter covers the research design, population and sampling, data collection and data analysis methods.

3.2 Research Design

The research will employ the exploratory research design. Exploratory research is research conducted for a problem that has not been studied more clearly, intended to establish priorities, develop operational definitions and improve the final research design (Bryman & Bell, 2015). Exploratory research helps determine the best research design, data-collection method and selection of subjects (Creswell, 2014).

Based on the reviewed literature, this study established that blockchain applications in supply chain management are not fully understood. There has been no research focusing on the blockchain applications in supply chain management. To date, most of the research focusing on blockchain technologies has focused on cryptocurrency applications as well as cryptanalysis and cryptography security features. Other areas such as smart contracts and private blockchains have been hardly explored especially in Kenya. This study seeks to build a platform upon which future research was conducted hence the use of an exploratory research design.

3.3 Population and Sampling

This section focuses on the population and sample of the study. A population includes all the objects or elements of study. A sample is simply a subset of the population.

3.3.1   Population

The focus of the study was on supply chain management operators in Kenya. The study is more inclined towards the study of supply chain and logistics companies in the country. The assumption is that the specialized SCM and logistics firms dealing in international trade as well as local trade would be well versed with the current applications of specialized technology in supply chain management. The population would also well versed with the challenges facing the supply chain management sector with the current technologies as well as with the adoption

of blockchain technologies. Additionally, the research considers that firms in this space would also point to the extent to which blockchain technologies are being adopted in the supply chain management sector and the areas of SCM that are majorly impacted by the blockchain technologies. Overall, the population would be able to note impacts of technology on supply chain efficiency as well as management efficiency of the supply chains.

3.3.2   Sampling Methods

The study, at this stage, has not determined the population of logistics business in the country. Consequently, the study considers to use the unmodified Cochran's formula for the determination of the sample size. The unmodified Cochran's formula is as shown in the image below (Cochran, 2007).

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where e is the desired level of precision, p is the (estimated) proportion of the population which is considering blockchain in SCM, q is proportion of the population which is not considering blockchain in SCM and is equal to $1 - p$. The study assumes that 50% of the population is considering blockchain in SCM and that 50% is not considering blockchain in SCM. The required confidence level is 95% (Cochran, 2007). Using these assumptions, the formula returns a recommended sample of 384 research participants.

Targeting a sample size of 384 research participants, the study will employ simplified random sampling technique to reach as many supply chain managers as possible across the country (Creswell, 2014). The research tool was emailed to supply chain managers in different companies across the country. The researcher will also call the supply chain managers to inform them of the research objectives.

The study targets to get 60% to 80% response rate out of the targeted sample of 384 research participants. To attain the sample size, the study will use electronic means of administering the tool of data collection making it easy for participants to share the tool (Sekaran & Bougie, 2016). At the same time, the tool of data collection was designed to attract the highest response rates possible by ensuring that the exercise is not time-consuming (Creswell, 2014).

The sampling criteria of the study focused on professionals in procurement and all areas of supply chain management. To access the population and the sample, the study contacted Kenya Institute of Supply Chain Managers (KISM). This enables the study to collect data from the persons believed to be in contact with the day to day running of supply chain management in Kenya.

3.4 Data Collection Methods

The study will use primary data. Primary data is also called raw data or original data that has been collected specially for the purpose in mind (Creswell, 2014). The need to use primary data is created by the fact that there has been no research focusing on application of blockchain technology in supply chain management in Kenya hence no secondary data available on the subject.

Data was collected using a questionnaire (Walliman, 2017). The questionnaire was divided into four sections guided by the specific research objectives as expressed in Chapter One of the study. All questions on the questionnaire was close-ended with responses expected on a Likert scale. Close-ended questionnaires allow for quantitative analysis of qualitative information.

In the general information section, the study will collect data on the roles held by the respondents for the study. The focus of the study is to reach out to players in supply chain management industry who have a decision-making capacity specifically on the deployment of technology. Considerations such as years of experience will also be important. The goal is to collect data from credible sources and attain the highest possible levels of reliability in the study.

The tool was administered electronically using Google Forms. The goal is to make it easy for the respondents to access the tool and at the same time to enable easy sharing of the questionnaire through a hyperlink. Considering the targeted sample for the research, the use of Google Forms will also enable efficiency in the organization of the data set.

3.5 Validity and Reliability

Validity is a measure of meaningfulness and accuracy of inferences. The findings of the study were focused on measuring the potential impact of blockchain technologies on total supply chain efficiency. The consideration was whether the collected data would result in accurate

inferences on total supply chain efficiency. In this consideration, validity wase considered from the aspect of predictive power of the data collected using the tool. Consequently, the data was tested for predictive validity (Sekaran & Bougie, 2016).

Reliability, on the other hand, is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. In this regard, the research tested internal consistency of the data collection tool. Reliability testing focuses on answering the question whether the tool of data collection is able to generate internally consistent data. This is important at the tool design stage (Sekaran & Bougie, 2016).

To establish the validity and reliability of the tool and the data, the research employed the use of Cronbach Alpha. The computation of Cronbach alpha was done after a pretest of the research tool in which the pretest used 11 responses. The minimum acceptable Cronbach alpha is 0.70. To generate highly reliable data, the study targeted a Cronbach alpha of at least 0.95 (Sekaran & Bougie, 2016).

After running the reliability test using Cronbach Alpha, the research generated an alpha value of 0.862. This indicated that the tool was internally consistent. The study also considered the possibility of any items in the data that may have resulted in reduced internal consistency of the data da the following findings were made.

TABLE 1: CRONBACH ALPHA

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Supply Chain Efficiency	50.09	153.691	.472	.856
Decision-making Capacity	50.64	164.655	-.120	.866
Technology Decisions	50.27	160.818	.145	.864
Blockchain Awareness	50.09	154.091	.387	.858
SCM Costs	49.55	160.073	.167	.863
SCM Provenance	49.00	151.800	.502	.855
SCM Traceability	49.00	149.600	.606	.852
SCM Transparency	49.55	150.673	.452	.856
SCM Time Efficiency	49.00	150.800	.549	.854
SCM Order Fulfilment	48.82	158.964	.109	.868
Total Supply Chain Efficiency	48.55	147.473	.579	.852
Blockchain in SCM	48.82	158.564	.139	.867
Considered Adoption of Blockchain	49.09	144.291	.679	.848
Possible Adoption Blockchain in SCM	48.45	144.473	.507	.854
Disruption of SCM by Blockchain	48.55	164.873	-.083	.877
Blockchain and Provenance	49.09	131.891	.819	.838
Blockchain and Traceability	49.00	134.400	.749	.842
Blockchain and Transparency	49.09	129.091	.866	.835
Blockchain and Time Efficiency	48.82	133.764	.663	.846
Blockchain and Total Supply Chain Efficiency	49.09	135.291	.627	.848
Technology Diffusion	50.00	162.600	.049	.865

3.6 Data Analysis

Data analysis was completed in IBM Statistical Package for the Social Sciences (SPSS®). To establish the extent of adoption of blockchain technologies in supply chain management, the study used descriptive statistics including means, modes, and medians. To determine the relationship between blockchain technologies and total efficiency in supply chain management, SPSS was used in deriving a predictive model using ordinal regression model. The model was used to determine the extent to which adoption of blockchain technologies would influence total supply chain efficiency. Total supply chain efficiency is the dependent variable in a regression model where extent of adoption blockchain technologies, and opportunities of blockchain in SCM are the independent variables in the research. All tests was conducted at 95% confidence interval.

The ordinal regression is provided as follows:

$$Y = a + b1X1 + b2X2 \ldots + e$$

Where:

Y= Total Supply Chain Efficiency, X1=Traceability, X2=Provenance, X3=Cost Efficiency, X4=Time Efficiency, X5=Order Fulfilment, and a, b1, b2, b3, b4, b5 are constants. e is error.

Lastly, to determine opportunities of blockchain technologies in supply chain management the study used descriptive statistics.

The analysis of data will also include vast descriptive statistics focusing on factors such as the diffusion of innovations among other essential information that explains the relationship between blockchain technologies and total supply chain efficiency.

CHAPTER FOUR: RESULTS AND DISCUSSION OF FINDINGS

4.1 Introduction

The research objective was to explore perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. Data was collected by the use of a questionnaire which was administered electronically. Chapter four presents the results and findings of the study based on the data.

4.2 General Information

This section data that was not used qualifying the data collected and used in the study. Information provided in this section includes response rate, the experience of the respondents in supply chain management, involvement of respondents in making technology selection decisions, and rating of the respondents based on the diffusion of innovation theory.

4.2.1 Response Rate

Data was collected from a total of 210 respondents. The response rate was lower than the targeted 384 responses. The research however considered that the number of responses received was adequate for the conduct of statistical tests, that the responses were representative of the supply chain management practitioners in Kenya, and that the responses could be used to make inferences about the population of research.

4.2.2 Respondents' Experience in Supply Chain Management

The experience of the respondents ranged between one year and twenty-four years. The experience levels demonstrated extensive diversity in the knowledge of the respondents about supply chain management and particularly the areas of supply chain management that needed further attention. Figure 1 is a histogram showing the frequencies of the experience levels of each of the respondents in years. The average experience level in years was 10.76 years.
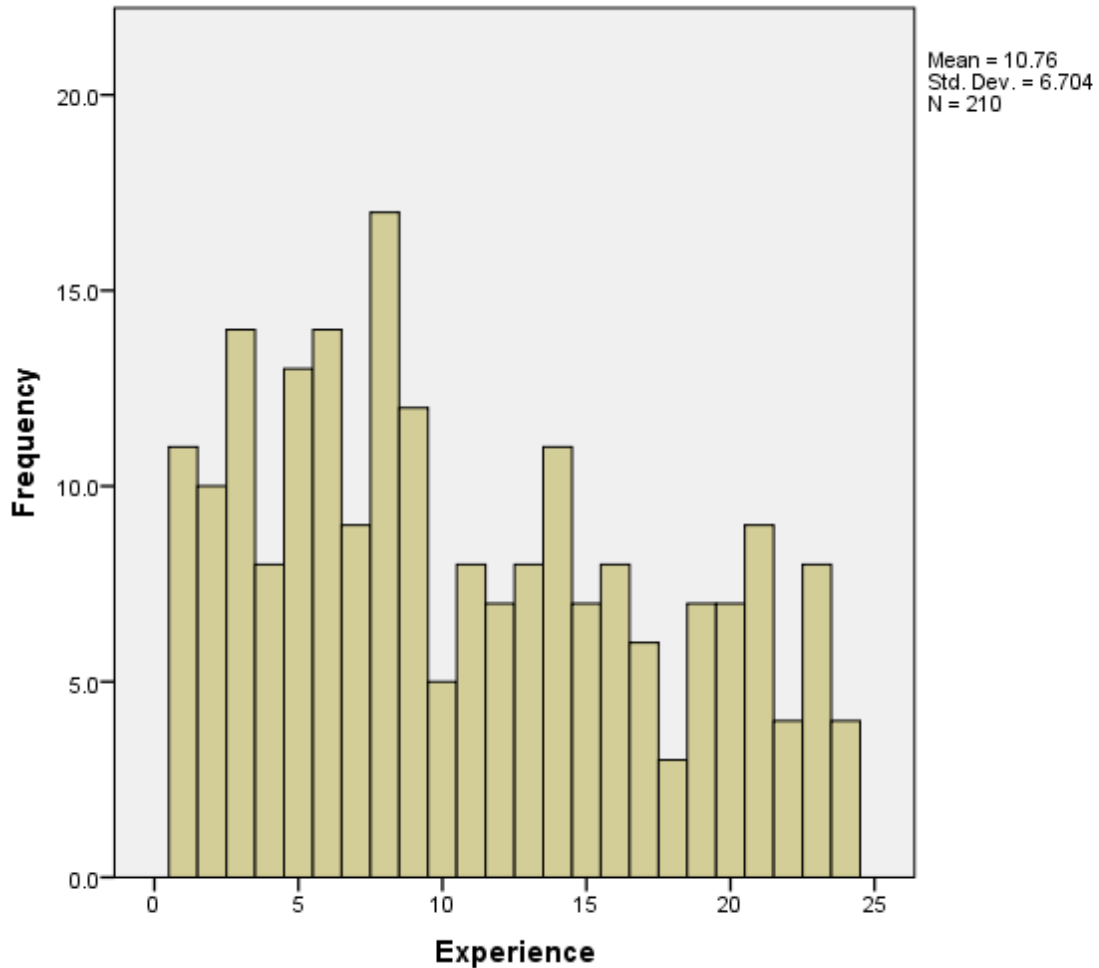
FIGURE 2: RESPONDENTS' EXPERIENCE IN SCM

4.2.3 Awareness of Blockchain Applications in Supply Chain Management

Other factors considered in the general information of the research included the consideration

of whether supply chain efficiency was considered a problem. The study also targeted to

determine whether the respondents were in a position to influence the decisions on adoption of

technologies in supply chain management in their companies. Findings of the study indicated

majority of the respondents may not have been in a decision-making capacity but they had

been involved in decisions on the selection of technologies in supply chain management. The

implications were that the respondents were found to have the necessary knowledge to respond

to questions about the adoption of blockchain technologies in supply chain management. Findings of the study were as presented in Table 2.

TABLE 2: DESCRIPTIVE STATISTICS ON GENERAL INDICATORS

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Experience	210	1	24	10.76	6.704
Supply Chain Efficiency Problem	210	1	3	2.05	.799
Decision-making Capacity	210	1	3	1.99	.810
Technology Selection Decisions	210	1	3	2.06	.828
Blockchain Applications Awareness	210	1	3	1.88	.824
Valid N (listwise)	210				

4.2.4 Diffusion of Innovation in Supply Chain Management in Kenya

The last major consideration under the general information was the innovation diffusion theory which helps in explaining how supply chain managers adopt new technologies. 24% of the respondents indicated that they are innovators while 20% early adopters. This leaves the majority in the categories of early majority, later majority, and laggards at the rates of 24%, 32%, and 0% respectively. Consequently, majority of the respondents would be expected to demonstrate tendencies consistent with some level of skepticism towards blockchain applications in supply chain management.
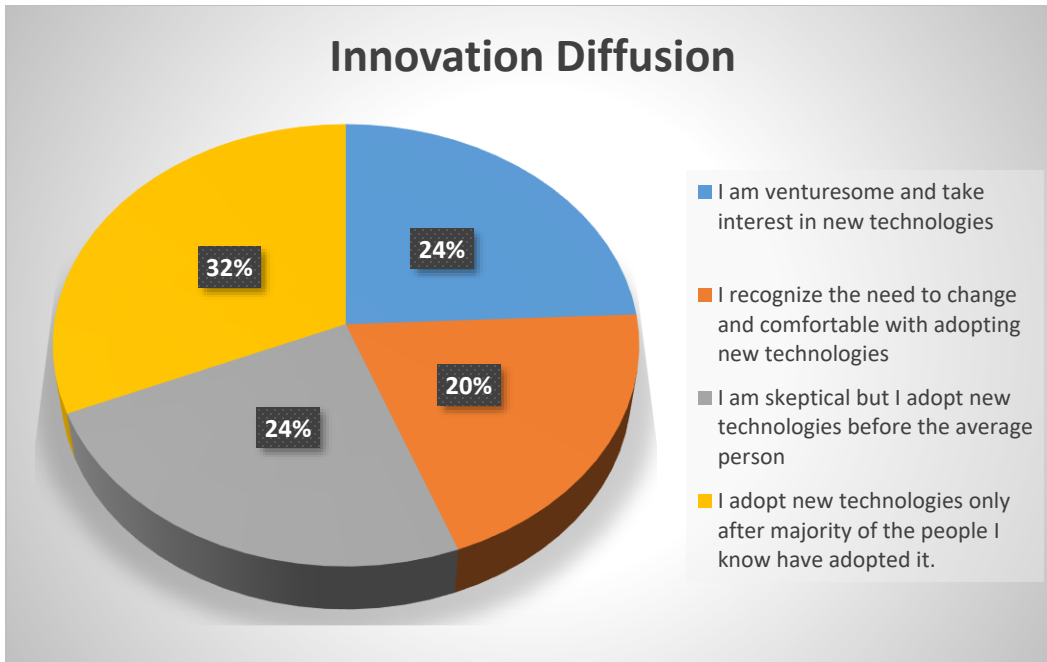
Innovation Diffusion

- I am venturesome and take interest in new technologies
- I recognize the need to change and comfortable with adopting new technologies
- I am skeptical but I adopt new technologies before the average person
- I adopt new technologies only after majority of the people I know have adopted it.

24%
20%
24%
32%

FIGURE 3: DIFFUSION OF INNOVATION IN SCM

4.3 Adoption of Blockchain Technologies in Supply Chain Management

On a scale of 1 to 3 where 1 is "yes", 2 is "no" and 3 is "may be", the research indicated that majority of the respondents were not aware of any blockchain applications in supply chain management, given an average score of 1.88. The finding was considerably so because research in blockchain applications in supply chain management was fairly new with only a few early starters that included Chronicled®, Everledger®, Skuchain®, Blockverify®, ubirch®, and Provenance®. The study also considered that the limited awareness of blockchain applications in SCM was because a lot of past research focused on the cryptocurrency applications of blockchain technologies thereby masking all other applications of the technology.

In Kenya blockchain applications in supply chain management began in in late August, 2018 while this study was conducted in November the same year. This meant that many of the practitioners may not have heard of the few attempts to employ the technology in supply chain

management. This explained the finding that majority of the respondents may not have been aware of any SCM applications of blockchain technologies.

4.4 Potential Impact of Blockchain Technologies in Supply Chain Management

The study established that there existed a positive relationship between cost efficiency, provenance, traceability, time efficiency, and order fulfilment as independent factors, and total supply chain efficiency as the dependent factor. The finding was established after conducting the PLUM ordinal regression analysis. Ordinal regression is a statistical technique that is used to predict behavior of ordinal level dependent variables with a set of independent variables. Findings of the regression analysis were as shown in the table below.

TABLE 3: ORDINAL REGRESSION STATISTICS

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	30.068			
Final	0.000	30.068	15	0.000
Pseudo R-Square				
Cox and Snell		0.935		
Nagelkerke		1.000		
McFadden		1.000		
Link function: Logit.				

The study found that the ordinal regression using the factors above had a maximum explanatory power of 93.5% thereby demonstrating that cost efficiency, provenance, traceability, time efficiency, and order fulfilment as independent factors were critical factors in explaining total supply chain efficiency. Only 6.5% of the changes in total supply chain efficiency were not explained by the factors introduced above. This indicated the importance of focusing on the five areas of supply chain efficiency as the key areas of innovation with the goal of improving total supply chain efficiency.

4.5 Opportunity of Using Blockchain technology in Supply Chain Management

While there was a strong relationship between total supply chain efficiency and the five key factors addressed in the research, the study established that total supply chain management was rated lowly under the current technologies. The average rating on each of the factors was between 2 and 3 which is basically a rating indicating the total supply chain is between acceptable and good. These findings were consistent on all five factors as demonstrated in the table 3.

TABLE 4: KEY VARIABLES BEFORE BLOCKCHAIN

Statistics	N	Mean	Median	Mode
SCM Costs	210	2.51	2	4
SCM Provenance	210	2.36	2	1
SCM Traceability	210	2.5	2	2
SCM Transparency	210	2.45	2	3
SCM Time Efficiency	210	2.57	3	3
SCM Order and Transaction Fulfilment	210	2.51	3	1
Total Supply Chain Efficiency	210	2.51	2.5	2

Respondents strongly believed that application of blockchain technologies would improve total supply chain efficiency to some extent. With a median rating of 4, the respondents indicated that blockchain technologies would disrupt supply chain management to a moderate extent. The aspect that would be affected to a large extent was found to be traceability in supply chain management. The respondents also believed that the factor that would be disrupted the least was provenance. The challenge, however, was the fact that the respondents considered that it would be difficult to have the blockchain technologies by accepted and applied in supply chain management in the country. Table 4 below shows the rating of the respondents on the opportunities offered by the blockchain technologies in supply chain management.

	N	Mean	Median	Mode
Familiarity with Blockchain Applications in SCM	210	3.38	3	3
Consideration of Blockchain Applications in SCM	210	3.57	4	5
Possible Adoption Blockchain in SCM	210	3.3	3	2
Disruption of SCM by Blockchain	210	3.55	4	5
Blockchain and Provenance	210	3.39	3	3
Blockchain and Traceability	210	3.6	4	5
Blockchain and Transparency	210	3.42	3	3
Blockchain and Time Efficiency	210	3.48	3	3
Blockchain and Total Supply Chain Efficiency	210	3.42	3	2

The tables above demonstrate that under the application of blockchain technologies efficiency in supply chain management was expected to improve significantly. This is because of the strong belief that blockchain technologies would result in improvements in traceability as a major concern for the supply chain managers. Major improvements would also be recorder in all other aspects including cost efficiency, time efficiency, order fulfilment, and provenance. Findings of the study were consistent with the prevailing views on blockchain applications in supply chain management. Traceability is considered the major area of impact of the technology considering that a product can be traced back to the producers. Concerns such as the traceability of products through a manufacturing process however prevail and may require different approaches to solve.

4.6 Chapter Summary

In summary, the study proved the existence of a strong positive relationship between factors of cost efficiency, traceability, provenance, order fulfilment, and time efficiency and, total supply chain efficiency. The study found that the respondents lowly rated total supply chain efficiency under the prevailing technologies. They also considered that total supply chain efficiency would improve significantly under blockchain applications of supply chain

management. Traceability conspicuously emerged as one of the factors that would be greatly affected by blockchain technologies. Concerns were however raised on the possibility of early adoptions of the technologies. The concerns were consistent with the finding that majority of the respondents were early majority, later majority, and laggards in the adoption of technology innovations based on the theory of diffusion of innovations.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five is the last chapter of the study. It focused on the summary of the research findings, the conclusions, and the recommendations.

5.2 Summary

The research objective was to explore perception of procurement professionals on the adoption of blockchain technologies and its impact on supply chain management in Kenya. The specific objectives of the study included to establish the extent of adoption of blockchain technologies in supply chain management, to determine the relationship between blockchain technologies and total efficiency in supply chain management, and to explore opportunities of blockchain technologies in supply chain management.

On extent of adoption of blockchain technologies in supply chain management, the study found that there was limited awareness of the current attempts to apply blockchain technologies in supply chain management in Kenya. This was despite there being trademarks such as Chronicled®, Everledger®, Skuchain®, Blockverify®, ubirch® and Provenance® which are focusing on blockchain in SCM globally. In Kenya, similar attempts were made a few months prior to the conduct of the research. The research finds that the fact that blockchain is more popular for cryptocurrencies may have affected the awareness of the participants about supply chain applications of the technology.

On the relationship between blockchain technologies and total efficiency in supply chain management the study found a strong relationship between cost efficiency, provenance, traceability, time efficiency, and order fulfilment as independent factors, and total supply chain efficiency as the dependent factor. Ordinal regression recorded a Cox and Snell R-square of 0.935 indicating that a strong relationship existed between the factors of the research and total supply chain efficiency. With this confirmation, the study also found a strong positive relationship between total supply chain efficiency and blockchain applications.

Focusing on the opportunities of blockchain technologies in supply chain management. The research established that improved traceability would be the greatest opportunity for the application of blockchain technologies in supply chain management. Substantial improvements would also be recorded in all other aspects of supply chain management

including the areas of provenance, cost efficiency, time efficiency, and order fulfilment among other important aspects of total supply chain management. The study found high potential for the application of blockchain technologies in supply chain management.

5.3 Conclusions

The study concluded that technology is a vital component of supply chain management. However, the current technologies applied in SCM do not adequately address the challenges of provenance, traceability, cost efficiency, time efficiency, and traceability, all of which are critical for total supply chain efficiency. This conclusion was reached based on the finding that majority of the respondents rated the current level of total supply chain efficiency as acceptable but not good. The finding is consistent with previous research that identified the five problems identified in this research as the key problems in supply chain management. The study also found that innovation and adoption of new technologies would help in dealing with the inefficiencies in supply chain management.

There exists a strong positive relationship between blockchain technologies and total supply efficiency. The respondents felt that adoption of blockchain technologies would greatly improve traceability. Currently available technologies use blockchain technologies to enhance the traceability of goods especially considering continued consideration of organically produced foods. The use of blockchain technologies is considered to enable the consumers to identify the source of their food and to actively determine whether it is healthy and whether the food is produced ethically.

Overall, the study concluded that adoption of blockchain technologies would greatly impact the total supply chain efficiency. This makes it necessary to consider the adoption of the technologies in supply chain management. In order to attain this there would be the need to focus more on research that involves the technical strengths and weaknesses of blockchain technology.

5.4 Limitations of the Study

The study reflects the potential benefits of adopting blockchain technologies in supply chain management. The data was collected through self-reporting in a closed-end questionnaire. While the research considers that all the main areas of focus in supply chain management were addressed, the research considers providing a platform where the supply chain managers and procurement professionals can fully express their opinions would be of more value to the

subject handled in the research. There should also be the focus on design and features of the technologies to determine the extent of possible integration with blockchain.

5.5 Recommendations

This section provides recommendations for improvement as well as recommendations for further research.

5.5.1 Recommendations for Improvement

This study recommends the adoption of blockchain technologies by the supply chain managers of Kenya. Early adoption of the technologies would enable the supply chain managers to influence the developments in the technologies hence ensuring that the technologies are tailored to the needs of supply chain management. At the same time it would give the supply chain managers of Kenya an edge over the competition due to early adoption of the technologies and the resultant efficiency of the supply chain.

5.5.2 Recommendations for Further Research

The study also recommends further research focusing on identification of the main concerns of the supply chain managers about the adoption of new technologies. The research should focus on collecting technical views of the supply chain managers. Such views should be included in the design of the blockchain applications for supply chain management.

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QUESTIONNAIRE

Section A: General Information

1. How long have you been in supply chain management?

   ……………………. Years

No.	Question	Yes	No	May Be
2.	Is supply chain efficiency a problem in your organization?			
3.	Do you have a decision-making capacity in supply chain management?			
4.	Are you involved in technology selection decisions in your organization?			
5.	Are you aware of any blockchain technologies targeting supply chain management?			

Section B: Adoption of Blockchain Technologies in Supply Chain Management

No.	Question	Not at all	To a small extent	To some extent	To a moderate extent	To a large extent
6.	To what extent are you familiar with blockchain adoptions in supply chain management?					
7.	To what extent have you considered blockchain applications in supply chain management in your organization?					
8.	To what extent are you likely to adopt blockchain applications in					

No.	Question	Not at all	To a small extent	To some extent	To a moderate extent	To a large extent
	supply chain management within the next 2 years?					
9.	To what extent are the current SCM technologies likely to be disrupted by blockchain technologies?					

Section C: Potential Impact of Blockchain Technologies in Supply Chain Management

No.	Question	Not at all	To a small extent	To some extent	To a moderate extent	To a large extent
10.	To what extent would blockchain technologies enhance provenance in supply chain management?					
11.	To what extent would blockchain technologies enhance traceability in supply chain management?					
12.	To what extent would blockchain technologies enhance transparency in supply chain management?					
13.	To what extent would blockchain technologies enhance time efficiency in supply chain management?					
14.	To what extent would blockchain technologies enhance order and transaction fulfilment in supply chain management?					

Section D: Opportunity of Using Blockchain technology in Supply Chain Management

No.	Question	Fair	Acceptable	Good	Excellent	Superior
15.	How are supply chain management costs under the current SCM technologies?					
16.	How effective are the current SCM technologies in enhancing provenance?					
17.	How effective are the current SCM technologies in enhancing traceability?					
18.	How effective are the current SCM technologies in enhancing transparency?					
19.	How effective are the current SCM technologies in enhancing time efficiency?					
20.	How effective are the current SCM technologies in enhancing order and transaction fulfilment?					
21.	How do you rate total supply chain efficiency under the current technology as applied in your organization?					

22. Which of the following statements best describes you?

- I am venturesome and take interest in new technologies
- I recognize the need to change and comfortable with adopting new technologies

- I am skeptical but I adopt new technologies before the average person
- I adopt new technologies only after majority of the people I know have adopted it.
- I am the last to adopt a new technology