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# A COMPARATIVE ASSESSMENT OF SUPPLY CHAIN EFFICIENCY: BLOCKCHAIN-BASED VS. TRADITIONAL MODELS IN AGRI-FOOD SECTOR

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**Abstract**
*The food value chain in agriculture has great significance with the supply of nutritious, accessible, healthy, and appropriate produce, feed, fiber, and fuel. The food supply chain system is a field of considerable significance as it provides customers with inexpensive, nutritious, and adequate bread and butter. The use of modern techniques are essential to ensure the smooth operations of these value chains. This study has presented comparative analysis between traditional and blockchain-based food supply chain system. Positivist philosophy has been used in this research because the sample population of research has been set the inclusion criteria as published findings obtained from SCI journals and books from credible research about blockchain-based food supply chain and other systems rather than blockchain. Data has been gathered by using the secondary data collection technique. The deductive nature of research has been used the grounded theory analysis to analyze the collected data in systematic methodology. And apply descriptive statistical and inferential statistical analysis (independent sample t-test) with the help of SPSS v 26. Due to the good performance and features of Traceability, credibility, integrity, and sustainability a blockchain-based food supply chain is most efficient than a traditional system. Results have monitored that a blockchain-based system has been used to fulfill the modern need of the supply chain in the future.*

## INTRODUCTION

### I. Introduction and related works

The supply chain refers to a prescribed mechanism to trace the product from the initial production stage, such as raw material to the manufacturing phase, retailer markets, and consequently consumer. The supply chain system must be secured, integrated, and provide maximum data reliability. Many supply chain systems are working nowadays; different systems work on different approaches by using different technologies. Some supply chain systems apply traditional technologies, i.e., cloud computing, big data, the internet of things, and artificial intelligence. Due to several reasons, including insufficient information, centralized management, and shareholder competition, they are monitoring goods by this traditional technology-based system makes it challenging to fulfill the modern need of the supply chain. (Musamih et al. 2021). The food supply chain is an integrative philosophy that controls the entire supply flow in the agricultural production chain from producer to consumer. It is a series of activities that promote effective supplier relationship management to meet customer requirements. These activities encompass all practices related to customer needs, efficient delivery of goods, data integration, information exchange, scalability, integrity, and traceability (Samal 2019). The agri-Food supply chains, which connect the critical events from food production to food processing, including trade, etc., have been related to the food supply chain. In most cases, through the agri-food supply chain, the information transferred from generation to generation in agriculture has evolved from a cultural point of view, but most of the time, it has not reacted to the needs or requirements of the agri-food supply chains. In addition, there is no such delineation between farms as economic units and farmers produce food, primarily for their consumption. Procurement, planning of production or scheduling, demand management or forecasting, control of inventory, demand of customer allocation, simultaneous location of the facility and demand allocation, planning of transport, etc., were the main processes and decisions (Dreyer et al. 2009). A comprehensive review of agri-food supply chain planning models has been shown to classify designing models according to related characteristics, such as the optimization approaches adopted, this type of processes involved, and the planning activities' scope. In the food supply chain, integrated planning approaches and models were minimal, particularly for natural products, as existing literature models do not incorporate original features, such as shelf life (Ahumada and Villalobos 2009). The first approach to developing and applying a methodology allows the food supply chain's quality and environmentally friendly. Furthermore, it explored the potential to study and compare the food supply chain's environmental impact using an analysis of energy demand. Further significant contributions to the control and monitoring of the entire process by the agri-food industry started from the production of goods by manufacturers to customers. (Chaabane, Ramudhin, and Paquet 2012). The supply chain for agriculture is a dynamic structure responsible for the flow of agricultural goods. Agricultural business resources, as a carrier for the circulation of agricultural goods, are considered essential assurance of meeting the demands of agricultural products and ensuring their protection and quality. More than 230,000 agricultural enterprises are working only in China, and many enterprises worked in the rest of the world (Leng et al. 2018). Since agricultural and food products are highly degradable, ambient temperature and humidity requirements are exceptionally high during the logistics phase. Agricultural and food management is a global problem. Due to a backward agricultural and food management system, 30% of food is lost annually in China alone. At the same time, in established countries such as Europe and America, the loss of agricultural and food products remains below 3% only because of good agricultural and food management. Therefore, in the current age of food security, food losses can only be reduced with modern technology (Tian 2016). The concept of a digital platform emerged as a combination of heterogeneous, open-source solutions to build an ecosystem. The European Union promotes digital platforms for various applications, such as the production of agricultural products, etc. The technology can provide various solutions to problems such as software process modeling, design, and development, analysis of functions, resource performance, test algorithms, or performance provide monitoring (Yablonsky 2018). Many times technology has been of positive help to the agricultural sector and has helped in other areas. Especially in the areas of intelligent farming, robotics, information management, and remote sensing technologies have reached many milestones that contribute to the growth and prosperity of agriculture; big data, robotics, cloud computing, and artificial intelligence are some of the most used areas by you. These technologies provide a data-driven facility in intelligent farming and connect all of the independent elements connected to the central system. Through semantically active technologies, the processes of every agricultural process are automatically integrated into the food chain and reach the end consumer (Mondino and Gonzalez-Andujar 2019). The agri-food industry is striving to diversify to meet the growing demand for fresh and healthy products. After harvest at yard gates, storage yards, wholesale and retail markets, the loss of fruit and vegetables poses many problems. Food manufacturers have shown interest in using blockchain to ensure food safety, quality, traceability, traceability, and post-harvest management - complex and confusing issues in the food supply chain (Rejeb and Rejeb 2020). The IoT-based water supply chain traceability and provenance solutions have been constructed with the help of centralized infrastructures, leaving the potential for unresolved concerns. It has been caused potentially significant vulnerabilities, such as data integrity, manipulation, and single points of failure. Blockchains, the distributed ledger technology, is a novel and inventive approach to implementing decentralized, trustless systems. This would prevent corruption caused by a lack of source documentation. The decentralized solution has been Aqua-Chain; it was a completely decentralized, blockchain-based traceability solution for handling the water supply chain. It enabled seamless integration of IoT devices that generated and consumed digital data along the chain. It allows for seamless integration of software systems. The controller was a component that converted high-level function calls to the blockchain layer's corresponding low-level calls. Block-chain was the system's primary component, containing all business logic that was executed via smart contracts on the blockchain. It served as a gateway to the blockchain itself (Maouriyan and Krishna 2019). Block-chain technology is a novel paradigm for distributed, decentralized, and irreversible record databases that has piqued the interest of various scholars and businesses in recent years because of the advantages it potentially gives over proposed methods in a variety of domains and purposes. Among many advantages, blockchain technology can provide data transparency and consistency with no need for a 3rd party and is well adapted to solving challenges in areas where a large number of untrustworthy players must operate/work together. The differences between traditional supply chains and blockchain-based supply chains have been discussed as it is beneficial to implement blockchain in various sectors such as automobiles, pharmaceuticals, food, and retail. The traditional supply chain has faced many problems, such as insufficient visibility from one end to the other, which leads to many problems such as fraud, code violations, etc. In addition, globalization often led to changes in demand, which indirectly increased operating costs. Moreover, due to the lack of trust, the correct transmission of information from one party to another was impossible. Ineffective supply chain risk management systems could not anticipate risks and respond appropriately to changing conditions. Traditional supply chain management lacks the advanced technologies needed to address the problems that have arisen as a result of the sudden developments of globalization (Aich et al. 2019). The automotive supply chain using blockchain technology can be implemented in two ways: as a logistics service or as a distribution channel service for distributors and importers. It was difficult to control counterfeit medicines and the quality of medicines in the traditional medicine supply chain, as the whole system was opaque. However, with the help of a blockchain system that supports the Internet of Things, a product can be identified by a Global Trade Item Number, expiration date, and serial number, all of which are available to anyone connected to the supply chain network. Foodborne diseases are mainly due to contamination, which has been challenging to identify in managing new food supplies due to its lack of transparency. However, an integrated blockchain system for the Internet of Things can overcome this problem by offering a neutral platform and eliminating the need for third-party participation in the system. In the case of retail, the critical problem here was the establishment of consumer confidence, which was difficult to achieve given the opaque nature of the system. By building consumer confidence, a blockchain-based system can solve these problems. Each product in this system has a unique digital identifier that stores all product information from the point of origin to the point of sale (retail store). Blockchain-based seafood supply chain system case study analyzed. It will ensure the transparency of the supply chain—lower operating costs and save time. In addition, consumer and seller confidence improved as both parties knew what they were buying(Baralla, Pinna, and Corrias 2019). The agro-food industry is an example of such a sector. . What individuals consume has become increasingly important, particularly concerning safeguarding. Managing product quality and compliance with current standards across the meal industry's supply chain is a huge concern today, particularly when it comes to traditional food goods, which are items that are intimately related to their geographic location. Unlike other distribution networks, the value of agro-food items can alter continually throughout the distribution chain, from the moment natural resources depart the farmer until the time the goods reach the customer. Furthermore, the usual agro-food supply chain works manually, i.e., all the supply management and product tracing perform without the use of computerizes system, food supply chain conventionally work on manual paperwork on the origin, and dietary qualities are usually kept on paper or in secret databases. Therefore, it can only be viewed by responsible third parties (Cocco et al. 2021). Today, with the advent of big data, the internet offers vast, complex, and critical knowledge. Confidence in data has dropped significantly, allowing industry and organizations to address privacy and data protection issues daily. The power of blockchain technology lies in the transformation of future scenarios in the food value chain. Thanks to encrypting algorithms and hashing, blockchain makes blockchain one of the most powerful new technologies for maintaining anonymity and security. Block-chain offers consensus mechanisms, i.e., HOUR. PoS and DPoS ensure data legitimacy and data integrity and make adaptive food supply chain management legal (Vangala et al. 2020). A blockchain-based resource for agricultural businesses can provide adaptive pension search and matching mechanisms for a public service platform. Not only should the confidentiality and protection of records and the security of business information be ensured, but the integrity of the public service structure and the overall benefits of the mechanism should be significantly improved (Dai, Zheng, and Zhang 2019).

Because of its decentralized approach and integrity, blockchain technology has chosen to create a traceability framework for the food supply chain. The system is protected by a complete data collection and information management process for all links in the agri-food supply chain that monitors quality and safety, tracks and manages the traceability of agri-food products from producer to consumer (Chen et al. 2019). "It is being censored to ensure that food supply chains are working reasonably well using traditional technologies. The traditional systems and blockchain-based food value chain systems need to find out which method is safer and more efficient for supply chain systems in agriculture and the food industry. The study will highlight the shortcomings of traditional systems and the future of blockchain-based systems in the value chains of the agro-food industry. The carbon footprint chain (CFC) is considered as one of the solutions to track the pre-consumption stages of the food life cycle. This system is simple to implement and highly scalable. There were three sorts of nodes in the proposed CFC: leader, follower, and candidate nodes. Each block comprises information on the commodities transported, the carbon impact, the mileage, and prior clusters. When trucks moved food from one step to the next, transaction records were recorded(Shakhbulatov et al. n.d.). A thorough examination of future opportunities, new requirements, and design principles for blockchain-based supply chain management solutions was done. Four major technological concerns, including scalability, throughput, access control, and data retrieval, were identified and studied, as well as potential solutions. The technology was based on the blockchain as a Service concept (BaaS). BaaS was a cloud-based service that enabled users to create, put on, and utilize their blockchain applications (Chen et al. 2019). A blockchain-based system for traceability of agri-food supply chain framework considered the five major phases under the "European F2F model". The phases were production, processing, distribution, retailing, and consumption. The system architecture had three layers, i.e., the physical layer, digital data layer, and blockchain layer. The physical layer contained a variety of products of organizations that are involved in the supply chain. The digital data layer entailed every piece of data associated with the products in the physical layer. The layer of blockchain technology is utilized to save the digital traceability data for each individual. The system was implemented in Hyper-ledger Saw-tooth. The techniques that were used were called Engineering for Agile Blockchain Development (ABCDE). This technique entailed a first examination of the issue at hand from a platform in a completely neutral manner. It started from the objective's definition and the identification of the principal actors of the framework. With the adoption of blockchain technology, the system was divided into two parallel workflows. These were the blockchain technology (smart contracts) and its applications (Baralla, Pinna, and Corrias 2019). Blockchain technology has been used in the supply chain management of food goods—the hybrid architecture of database and blockchain technologies. Additionally, the traceability of food goods was segregated into several components known as links. "Production," "processing," "logistics," and "sales" were the four connections. Generally, the steps of agriculture product development included planting the seed, transferring it, watering it appropriately as required, fertilizing it, and lastly, harvesting the end products, which were fruits or vegetables. All of these steps of development were incorporated into the architecture's "production link." After harvesting fruits and vegetables from agriculture, the food is classified, weighed, and packaged in exquisite packaging. This stage of food processing was added to the 'processing' link. Additionally, the proposed architecture included a transportation link. The connection has been created to manage the transportation process involved in the manufacture and processing of food goods, as well as the transportation aspects associated with the selling process. Additionally, the suggested system defined four tiers. The storage layer, the service layer, the interface layer, and the application layer were among these layers. (Yang et al. 2021). In the food service industry, blockchain technology has emerged as a potential technology with far-reaching implications. Immutability, increased visibility, traceability, and data integrity are all advantages that boost confidence in global food supply chains. Blockchain can improve traceability, make recalls more efficient, and reduce the risk of counterfeit items and other kinds of illegal trading. The key advantages of blockchain technology in the food supply chain are increased food safety and security. And also improved traceability, collaboration, process efficiency, and streamlined food trade operations are all benefits of the new system. Technical, organizational, and regulatory concerns are all possible obstacles(Rejeb and Rejeb 2020). Distributed ledger (blockchain) technology is a revolutionary technology for shared, decentralized, and irreversible ledger data that has piqued the interest of several scholars and businesses in recent years because of the advantages it potentially gives over proposed methods in a variety of domains and uses. Among many advantages, blockchain technology can provide data integrity and consistency without a 3rd party and is well suited to solving challenges in sectors where a large number of untrustworthy players must function jointly. The agro-food industry is an example of such a field. What individuals consume has become increasingly important, particularly in terms of health and safety. Managing item safety and reliability with current standards across the food company's supply chain is a huge concern today, particularly when it comes to traditional food goods, which are items that are intimately related to their geographic location. Unlike other distribution networks, the value of agro-based items can alter continually along their distribution chain, from the moment natural resources depart the farmer until the time the goods reach the customer. Furthermore, the usual agro-food distribution network is under-digitalized. Typically, food information on the origin and nutritional qualities is kept on paper or in secret systems and may only be reviewed by reliable party agencies.

Today, the internet provides immense, complex, and vital knowledge because of Big Data's advent. Trust in data has decreased significantly, enabling industry and organizations to raise protection and privacy issues by day. The power of blockchain technology is to transform future scenarios of the food supply value chain. Using algorithms and hashing, the blockchain makes blockchain one of the most powerful novel technologies to maintain anonymity and protection. The blockchain provides consensus mechanisms to provide data and data integrity legitimacy, making adaptive food supply chain management legitimate (Vangala et al. 2020). A blockchain-based agricultural business resource can provide adaptive rent-seeking and matching mechanisms for the public service platform. The confidentiality and protection of records and the safety of business information should not only be ensured but the integrity of the public service framework and the general usefulness of the mechanism should also be substantially enhanced (Dai, Zheng, and Zhang 2019). Because of its decentralized approach and integrity, blockchain technology preferred to establish a traceability framework for the agri-food supply chain. The system is protected by the entire data collection and information management process of all links in the agri-food supply chain that conducts quality and safety monitoring, tracking, and traceability management of agri-food from farm to fork. (Chen et al. 2019)". The food supply chain system is a field of considerable significance as it provides customers with inexpensive, nutritious, and adequate bread and butter. It is critical to ensure whether food supply chains are working smoothly and successfully by applying traditional technologies, i.e., cloud computing, big data, the internet of things, and artificial intelligence. A competitive analysis could provide a more accurate analysis of the most suitable system. The study will proceed to attain the following objectives:

- To compare the traditional and blockchain-based agri-food supply chain systems.
- To highlight the shortcomings of traditional systems while utilizing in the agri-food supply chain.
- To identify the forthcomings of the blockchain-based system in agri-food supply chains.
- To provide a systematic overview of the literature of both supply chain systems.

This study aims to compare two different technologies to highlight the distinguishing features of blockchain-based supply chain systems as compared to traditional systems.

## II. Methodology

### A. Sources and Description of Data

The investigative technique was employed in the data collecting process (Thompson 2009). The exploratory study used a variety of literary data sources, such as internet publications, published papers, government reports, and news stories, to perform the research. Due to the complex supply chain structure, the sample population of research has set as published findings obtained from journals and books about block-chain or supply chains, with the inclusion criteria of research articles from minimum SCI index journals, accepted dissertations, and conference articles from the official archive of institutes and books or summaries of books from Google books.

### B. Quality of Data

There were all of the relevant research articles included. These were first published in peer-reviewed scientific publications in the written word. The team of researchers used expert advice to establish and refine the qualifying criteria. To minimize relevant and non-related research, interpretation of findings was employed, such as blockchain-based supply chain, agri-food supply chain, local and regional data, and worldwide study on food supply chain before. The comparative nature of the study was required for inclusion; research was conducted in all contexts of blockchain or other technologies i.e., cloud computing, big data, the internet of things, and artificial intelligence. Regardless of the complexity of the dialect of execution; secondary outcomes were evaluated for assessment, and English language documentation was regarded for the results. Certain studies that did not support any of the above factors, such as study duration, the total number of events in treatment and comparative populations, important contextual characteristics characterization, and study population factors, were removed from the study. When it comes to studying independent variables, the impact of combining studies with studies from another perspective other than blockchain, as well as non-English language authored research articles, was evaluated. A subjective review was conducted exclusively based on the abstracts of the articles, which did not meet the inclusion criteria and did not meet the exclusion criteria. The article has gone over all of the articles to determine eligibility measures.

### C. Research Desing

This study has developed under the lines of qualitative study, which always use to work on novel topics; the study applied maximum theories and validate research methodology with the help of different philosophies and frameworks, which make this research more worthy and verified its outcomes. This research has provided a way forwards for the new researcher as well as become the most cited study for scholarly researches. The purpose of the research design is to offer a suitable systematic description. Qualitative data is converted to quantitative form to perform statistical analysis. In this research, the study design is dependent solely on the entire work approach of selecting the appropriate data collection method and establishing the procedure for obtaining data findings and analysis (Said Elsayed, Le-Khac, and Jurcut 2021) and In this study, a comparative analysis is applied to characterize current data as well as data for making predictions of a significantly compared analysis of conventional and block-chain-based food supply chains.

**D. Data Sources**

Food supply chains that link major events from food production to food processing, including trade, have been linked to the food supply chain. For the most part, information transmitted from generation to generation in agriculture has evolved culturally in the agri-food supply chain, but in most cases, it does not meet the needs or demands of agri-food supply chains. In addition, there is no such distinction between farms, as businesses and farmers produce food primarily for consumption. The food value chain in agriculture goes a long way towards providing nutritious, affordable, healthy, and suitable food, feed, fiber, and fuel. The food supply chain system is a critical area as it provides consumers with inexpensive, nutritious, and adequate bread and butter. The use of modern technology is essential to keep these value chains running smoothly.

Recent advances in software and infrastructure mean that "cloud computing can be implemented in agricultural supply chains to reduce costs and facilitate collaboration and coordination between different actors in the supply chain." For the current study, perspective, perspective, qualitative studies have been examined for the sake of relevant data. For data, the researcher examined the SCI index journals, ISI web of science, Google Scholar, and Google Books, IEEE, Web of sciences, Scopus, and others to investigate the critically comparative analysis of different blockchain or traditional agri-food supply chain data, already identified in peer-reviewed journals; open access publication/online publications; dissertations, and unpublished reports. Searched the literature using terms like "blockchain," "traditional agri-food," "supply chain," and "comparative analysis," among others. All of the studies' database lists were analyzed to continue this research project. Offered input on the search and were successful in identifying extensive literature when they researched comparative analysis of block-chain-based and traditional agri-foods supply chain. The researcher focused on human subject studies and research published in peer-reviewed publications in the English language through June 2021. Relevant papers from all interpreted publications (mainly based on eligibility criteria) were looked into to see whether any research initiatives had escaped the directory's thorough scrutiny. The information gathered from internet databases that were retrieved and procured based on comparative analysis of block-chain based and traditional agri-foods supply chain. Data collected independently from investigators utilizing correct technique and investigation. The availability of appropriate data is a critical concern in the current investigation.

**E. Sampling Technique**

The blockchain-based system works on the decentralized approach to provide more reliable resources to enhance traceability, credibility, and integrity of food items in the food supply chain. The data for this study were collected using a non-probability-based judgemental sampling technique. Judgment sampling, often known as judgmental sampling or authoritative sampling, is a non-probability sampling way the author chooses sample units based on prior information or professional judgement. (Elfil and Negida 2019). The results obtained with this sampling strategy are likely to be very accurate with a limited margin of error because the researcher's experience is employed to create a sample. The subjects in this method are chosen at the discretion of the researcher. This procedure has been heavily criticized due to the possibility of investigator bias. The study has been collected data for conduct comparative analysis to highlight the distinguishing features of blockchain-based supply chain systems as compared to traditional systems. Collected qualitative data represented in the five-point Likert scale. As how many percentages the relevant author agreed and discussed about the variable, as “0% agree”, 25% agree, 50% agree, 75%

agree and 100% agree. Then convert it into quantitative form and give them marks which range is 0-1 (0, 0.25, 0.5, 0.75, 1) for apply statistical descriptive and inferential tests. The criteria of this systematic data collection based on the study and their result, that how many percentages particular study will agree that blockchain provides better performance in agri-food supply chain in specific context (variable) sustainability, traceability, credibility, and integrity.

### F. Literature Search Strategy

Surveys, history, research, experimentation, and case studies have all been used to address research issues. These are beneficial research tactics. The current work attempts to enhance the correlation between variables and to meaningfully generalize a comparison between two different technologies. To gather data in a research study using a secondary data collection technique, you must first choose an appropriate and very well research methodology. The search method allows for a more direct way to finding relevant research articles for data gathering. A well-structured search technique is used in the current research investigation. Some keywords have been generated based on the research questions to aid in discovering and searching related papers on the online sources as part of the search approach (Booth et al. 2012). The construction and verification of a specific topic data to evaluate the similarities and differences in agri-food supply chain bases on different technologies, so blockchain, supply chain, agri-food chain, and food supply chain are the primary keywords that have been established for this research project. The research study was able to access a wider database by using these keywords. The databases contain a variety of content. Some acceptable and relevant papers were selected for review of the literature after a survey of various databases, only a small number of the papers chosen for this study are used in this study, which is categorized according to inclusion/exclusion criteria. Some particular criteria were suggested by the inclusion/exclusion criteria, such as the articles' trustworthiness, relevance, and updated articles (Thompson 2009). According to (Braymen et al. 2014), secondary data collection is a cross-sectional methodology that gathers data largely in many instances (usually ind a large number of them) and over a single period. At that point, the body of qualitative data was evaluated in combination with two or more variables (usually more than two). The well-developed idea of predictive value fueled the growth of polls (Corbetta and Shulman n.d.). This method is used to investigate supply chain processes or to experimentally and scientifically examine ideas, behaviors, and actions using a systematic approach. (Lin et al. 2017) claims the data collection technique has the following advantages: (1) a simple methodology for measuring behaviors, motivations, and values; (2) the ability to collect holistic perspectives from a wide range of groups. (3) a high level of uniformity that allows statistical analysis. The survey's previous section advantages include obtaining generic data from a wide range of people and a high level of uniformity, which allows for various statistical tests.

### G. Inclustion and Exclusion Criteria

- Ground theory analyses with systematic methodology from already published literature are considered.
- Papers focused on blockchain, agri-foods, supply chain data storage was considered in the current study.
- A research paper in the English language has been considered for the study.
- Publication years from 2017 to 2021 have been considered for the current literature.
- Quantitative, qualitative papers, peer review, gray literature, and conference papers are considered.

**Exclusion criteria are given below:**

- Translate papers and in other languages have not been considered for the study.
- Papers published before 2017 were not considered.
- Media or news articles
- Unrelated papers to blockchain or supply chain were not considered.
- Focus on other research designs e.g. case studies or trials.

### H. Data Analysis Techniques

The data has collected around the key variable of the research i.e. sustainability, integrity, creditability, and traceability, and compared each variable in blockchain-based as well as traditional food supply chains. In this study, a non-probability-based judgmental sampling technique will be used to collect data. Grounded theory analysis is used to analyze qualitative data in systematic methodology to produce useful derivations and information from collected data. The comparative analysis is considered as an argument-based analysis used to highlight the difference between two entities. The study will conduct a comparative analysis to highlight the distinguishing features of blockchain-based supply chain systems as compared to traditional systems. Collected qualitative data has been represented in the five-point Likert scale as how many percentages the relevant author agreed and discussed the variable, as “0% agree”, 25% agree, 50% agree, 75% agree and 100% agree. Then convert it into quantitative form and give them marks which range is 0-1 (0, 0.25, 0.5, 0.75, 1) for apply statistical descriptive and inferential tests. The criteria of this systematical data collection have on the base of the study and their result, that how many percentages particular study has agreed that blockchain provides better performance in the agri-fool supply chain in specific context (variable) sustainability, traceability, credibility, and integrity. Statistical Software for Social Sciences (SPSS-Version 26.0) was brought into use for data analysis. It uses descriptive statistics, numerical outcome projections, and group identification to analyze data. To help you manage your data successfully, this program also provides data processing, charting, and direct marketing capabilities. The qualitative data analysis approach was used to analyze the data acquired with the inclusion of secondary data. This is due to the data gathered from secondary sources in both theoretical and descriptive research. As a result, for data analysis, the research study used theme analysis methodologies. Some significant themes have been established and extracted from the literature using the thematic analysis method (Jamali 2018). The conclusions of the data have been assessed in light of those themes, and they are backed up by other literature sources. Descriptive and inferential statistical tests were used. In descriptive statistics, Maximum value, minimum value, range, mean, standard deviation, and variance have been computed. In inferential statistics, a t-test for two independent samples has been utilized. The T-test is used to check if there is a significant difference between the means of two systems.

## III. Result And discussion

### A. Content Analysis of Study

A comprehensive review of agri-food supply chain planning models has been shown to classify planning models according to relevant characteristics, such as the optimization approaches adopted, the type of processes involved, and the planning activities' scope. The data was collected around the key variable (sustainability, traceability, credibility, integrity) of the research to compare each variable in block-chain-based as well as traditional food supply chains. In this study non-probability-based judgmental sampling technique has been used to analyze data. In the course of content analysis, it has come into view that in all recent literature related to blockchain-based supply chain, more reliable than traditional supply chain because blockchain technology is a novel paradigm for distributed, decentralized, and irreversible record databases that has piqued the interest of various scholars and businesses in recent years because of the advantages it potentially gives over proposed methods in a variety of domains and purposes. Blockchain technology has been chosen to develop a traceability framework for the global food supply chain because of its decentralized approach and integrity. Whereas Due to several reasons, including insufficient information, centralized management, and shareholder competition, monitoring goods by this traditional technology-based system make it difficult to fulfill the modern need of the food supply chain. It has been illustrated that the traditional system considers the sustainability of the whole system as the key criteria of any food supply chain, which is not true, nowadays all technologies provide sustainability of the system. Sustainability ensures by new technological advancements in all traditional technologies. But it has not precise to say that sustainability ensures the perfectness of the food supply chain because the supply chain means to trace every good from farm to consumer. Blockchain-based supply chain ensures traceability as the essential characteristic of the food supply chain, which develops an argument that blockchain-based supply chains provide more traceability which needs into being for successfully working of the supply chain. Hence, blockchain bases, food supply chains are better than the traditional as shown in the figure below.

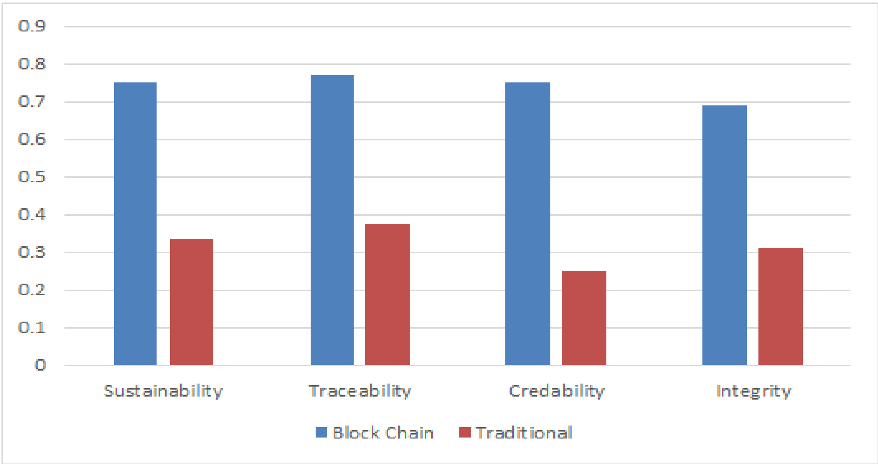


**Figure 1: Analysis of Blockchain and Traditional Variables**

The above bar plot shows the comparison between the variables of blockchain and Traditional. The blue bars show the "Blockchain" while the brown bars show the mean of "Traditional". Visually it is clear to see that the blue bars are higher than the brown bars which mean that the average of blockchain in Sustainability, Traceability, Credibility, and Integrity is higher than the average of Traditional in Sustainability, Traceability, Credibility, and Integrity. So it can be concluded that the Blockchain has better performance than the Traditional. It is also less feasible to centralize the framework to provide more traceability due to the decentralized approach of the agri-food supply chain. As compare the traditional supply chain system, it not decentralized that why the concept of traceability was never discussed a lot in included studies which also strengthen the argument built above that, most of the study consider traceability as a more important feature for any supply chain. Moreover, it could also be worth reviewing that credibility is one of the most discussed topics for blockchain-based supply chain whereas, in the traditional supply chain system, it never be discussed as the blockchain-based system which shows that the blockchain system, not only provide traceability, but it also increased overall credibility of the system. Credibility was the least discussed topic in traditional systems, which shown that traditional food supply chain systems lack the overall credibility of the system because it remains the less-discussed area. Hence the results are shown in figure 01. It clearly demonstrated that the blockchain base food supply chain system focus on reliability as these are much concerned about the traceability as well as whole creditability, integrity, and sustainability of the system which ensure the more scalable, efficient, and responsive system working under the decentralized approach of blockchain. The comparative analysis is considered as an argument-based analysis used to highlight similarities as well as the difference between two entities. The study has conducted a comparative analysis to highlight the distinguishing features of blockchain-based supply chain systems as compared to traditional systems. The years of publication always consider as a notable matrix of content analysis. It shows the tendency, implementation, and advancement in a particular field as well as the interest of researchers. In this study, content analysis has proved it has been

shown the number of publications regarding blockchain-based food supply chain has started increasing just after 2017. However, till 2018, traditional supply chain and blockchain bases food supply chain-related publications are equal in number but in the very next year of 2019, the number of publications has increased. Although the later number of publications per year decreased but still the blockchain-related publication publishes more than traditional. This trend showed the interest of researchers, scope of implementation, and positive outcomes from industry which qualify the blockchain-based food supply chain over the traditional supply chain which has shown as in figure 02.

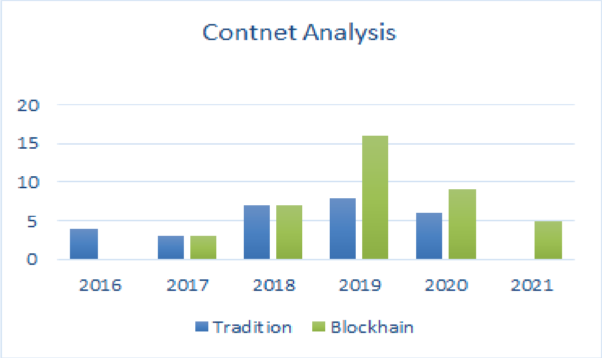


**Figure 2: Content Analysis**

**B. Descriptive statistics**

In descriptive statistics, Maximum value, minimum value, range, mean, standard deviation, and variance have been computed. Maximum and minimum values of the data show the highest and the lowest score of the blockchain and traditional. Mean is the average of the data which is the most important part of any analysis, so mean has provided the average score of both the variables of the study. Range, standard deviation, and Variance give the variation in the data.

**C. Inferential statistics**

In inferential statistics, a t-test for two independent samples has been utilized. The T-test is used to check if there is a significant difference between the means of the two samples. The criteria to determine the significant difference between the means two samples is the Probability value commonly known as P-value. If the p-value is less than the alpha (Level of significance = α) then we reject the null hypothesis. Usually, α is taken as 0.05 or 0.01. The null and alternative hypotheses are:

Ho: The means of BlockChain and Traditional are the same.

H1: The means of BlockChain and Traditional are not the same.

**D. Sustainability in Block Chain & Traditional**

Table 1: Summary Statistics of Sustainability in BlockChain

| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic |
| Sustainability_BlockChain | 12 | .50 | .50 | 1.00 | .8125 | .21651 | .047 |
| Sustainbility_Traditional | 12 | .50 | .00 | .50 | .2917 | .23436 | .055 |
| Valid N (list wise) | 12 | | | | | | |

**Table 1: Descriptive Analysis of Sustainability**

Table 1 shows the summary statistics of sustainability in the blockchain and traditional. The first column of Table 1 shows the sample size which is 12 and 12 for sustainability in blockchain and sustainability traditionally so the sample size is both are same. The 2nd column shows the range of the data in the blockchain and traditional which is 0.5, the range of both variables are the same. 3rd column of the table contains the minimum values which are 0.5 and 0.00 for sustainability in blockchain and sustainability in traditional respectively, while the 4th column shows the maximum values of the sustainability in blockchain and sustainability in traditional which are 1.00 and 0.5 respectively. The next column i.e. 5th column is considered to be the most important because it contains the mean values of both variables (sustainability in block chain and sustainability in traditional). The mean of sustainability in the blockchain is 0.8125 while the sustainability in traditional is 0.2917. Visually, it can be seen that the mean value of the blockchain is greater than the traditional. The 6th column contains the standard deviation and the 7th column shows the Variance of both variables. The standard deviation of sustainability in the blockchain is 0.21651 and 0.23436 for sustainability in traditional while the variance of blockChain and traditional is 0.47 and 0.055.

**Inferential Analysis,**
**Table 2: Mean comparison using t-test:**
**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Sustainbility | Equal variances assumed | .324 | .575 | 5.655 | 22 | .000 | .52083 | .09210 |

**Table 2: Inferential Analysis of Sustainability**

For the sake of comparing the means of both variables (Blockchain and Traditional), an independent sample t-test has been used and table 2 shows the output of the t-test. Before performing the t-test, Levene's test has been applied to check the assumption of the equality of variances, so it can be seen that the P-values of "F" is 0.575, so by the rule of thumb sig. > 0.05, we conclude that the assumption of the equality of variance holds. Table 2 shows that both the groups (blockchain and Traditional) are statistically significantly different because of the Sig. (2 tailed) is <0.05 or it can be said that the P-value 0.000 is less than the alpha value 0.05 so it shows that both the variables are statistically significant. From table 1, the mean of sustainability in the blockchain is 0.8125 while the sustainability in traditional is 0.2917. The mean difference between both the variables is 0.53083 which means that the average of blockchain is 0.53083 points greater than the Traditional. So we can say that the performance of blockchain is better than traditional while considering sustainability as a factor.

E. Traceability in BlockChain & Traditional

Descriptive Analysis:

**Table 3: Summary Statistics of Traceability in BlockChain**

| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| Traceability_BlockChain | 12 | .50 | .50 | 1.00 | .8125 | .21651 | .047 |
| Traceability_Traditional | 12 | 1.00 | .00 | 1.00 | .3750 | .31079 | .097 |
| Valid N (list wise) | 12 | | | | | | |

**Table 2: Descriptive Analysis of Traceability**

Table 3 shows the descriptive statistics of traceability in the blockchain and traditional. The first column of Table 3 shows the sample size which is 12 and 12 for Traceability in bock chain and Traceability in traditional, the sample size in both variables are the same. The 2nd column shows the range of the data in the blockchain and traditional which is 0.5 and 1, the range of both variables are not the same in this case. The 3rd column of table 3 comprises the minimum values which are 0.5 and 0.00 for Traceability in the blockchain and Traceability in traditional respectively, while the 4th column shows the maximum values of the Traceability in the blockchain and Traceability in traditional which are 1.00 and 1.00 respectively. The mean values of both variables (Traceability in bock chain and Traceability in traditional) are shown in the 5th column of table 3. The mean of Traceability in the blockchain is 0.8125 while the Traceability in traditional is 0.3750. Visually, the mean value of the blockchain is greater than the traditional. The 6th column contains the standard deviation and the 7th column shows the Variance of both variables. The standard deviation of Traceability in the blockchain is 0.21651 and .31079 for Traceability in traditional while the variance of block Chain and traditional is 0.047 and 0.097 respectively. The standard deviation and the variance show the spread of the data from the mean value and it is considered that the data having less variation is better than those having more variation. In this case, the spread of the blockchain is less than the traditional.

**Inferential Analysis:**

**Table 4:** Mean comparison using t-test:

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Traceability | Equal variances assumed | 1.269 | .272 | 4.001 | 22 | .001 | .43750 | .10934 |

**Table 3: Inferential Analysis of Traceability**

Similarly, for comparing the means of both variables (Blockchain and Traditional), an independent sample t-test has been used and table 4 shows the output of the t-test. Again, before performing the t-test, Levene's test has been applied to check the assumption of the equality of variances, so it can be seen that the P-values of "F" is 0.272, so by the rule of thumb sig. > 0.05, we conclude that the assumption of the equality of variance holds, which means that the variances of both the variables are the same. Table 4 shows that both the groups (blockchain and Traditional) are statistically significantly different because of the Sig. (2 tailed) is <0.05 or it can be said that the P-value 0.001 is less than the alpha value 0.05 so it shows that both the variables are statistically significant. From table 3, the mean of Traceability in the blockchain is 0.8125 while the mean of Traceability in traditional is 0.3750. The mean difference between both the variables is 0.43750 which means that the average of the blockchain is 0.43750 points greater than the Traditional. So we can say that the blockchain is better than traditional while considering Traceability as a factor.

### F. Credibility in BlockChain & Traditional

**Descriptive Analysis:**

Table 5: Summary Statistics of Credibility in BlockChain and Traditional

| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| Credibility_BlockChain | 12 | .50 | .50 | 1.00 | .7500 | .23837 | .057 |
| Credibility_Traditional | 12 | .75 | .00 | .75 | .3333 | .24618 | .061 |
| Valid N (list wise) | 12 | | | | | | |

**Table 4: Descriptive Analysis of Credibility**



Table 5 shows the descriptive statistics of Credibility in blockchain and traditional. As in previous tables, the first column of Table 5 is showing the sample size which is 12 and 12 for Credibility in bock chain and Credibility in traditional, the sample size in both variables is also the same in this factor so that the results remain unbiased. The 2nd column is showing the range of the data in the block chain and traditional which is 0.5 and 0.75 respectively, the range of both variables are not same in this case the range of Credibility (Traditional) is greater than the Credibility of blockchain which is showing the more variation of Credibility of Traditional as compared to the Credibility of Block Chain. The 3rd column of table 5 includes the minimum values which are 0.5 and 0.00 for Credibility in the blockchain and Credibility in traditional respectively, while the maximum values of the Credibility in bock chain and Credibility in traditional which are 1.00 and 0.75 respectively, shown in column 4. The mean values of both variables (Credibility in the blockchain and Credibility in traditional) are shown in the 5th column of table 4. The mean of Credibility in the blockchain is 0.75 while the Credibility in traditional is 0.3333. It can be visualized that the mean value of the blockchain is greater than the traditional. The 6th column contains the standard deviation and the 7th column shows the Variance of both variables. The standard deviation of Credibility in the blockchain is 0.23837 and .24618 for Credibility in traditional while the variance of block Chain and traditional is 0.057 and 0.061. The standard deviation and the variance show that the spread of the blockchain is less than the traditional.

**Inferential Analysis**

**Table 6: Mean comparison between Credibility of Block Chain and Credibility of Traditional t-test: Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Credibility | Equal variances assumed | .024 | .879 | 4.264 | 22 | .000 | .37500 | .08794 |

**Table 5: Inferential Analysis of Credibility**

To remain unbiased in the results, this study used the same testing technique in all cases. Like previous cases, for the sake of comparing the means of both variables (Blockchain and Traditional), the same independent sample t-test has been used in this case. Table 6 shows the output of the t-test. Levene's test was used to check the assumption of equal variances, so it can be seen that the P-values of "F-ratio" is 0.879, by using the rule of thumb sig. > 0.05, we can say that the assumption of the equality of variance exists, which means that the variances of both the variables (Credibility in the blockchain and traditional) are the same. Table 6 shows that both the groups (blockchain and Traditional) are statistically significantly different because of the Sig. (2 tailed) is <0.05 or it can be said that the P-value 0.000 is less than the alpha value 0.05 so it shows that both the variables are statistically significant. From table 5, the mean of Credibility in the blockchain is 0.75 while the mean of Credibility in traditional is 0.3333. The mean difference between both the variables is 0.37500 which means that the average of the blockchain is 0.375 points greater than the Traditional. So we can say that the Credibility of blockchain is better than the Credibility of traditional.

**G. Integrity in BlockChain & Traditional**

**Descriptive Analysis:**

**Table 7: Summary Statistics of Integrity in BlockChain**

| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| Integrity_BlockChain | 12 | .50 | .50 | 1.00 | .6875 | .21651 | .047 |
| Integrity_Traditional | 12 | 1.00 | .00 | 1.00 | .2917 | .35086 | .123 |
| Valid N (list wise) | 12 | | | | | | |

**Table 6: Descriptive Analysis of Integrity**

Table 7 shows the descriptive statistics of Integrity in the blockchain and traditional. Same as previous tables the first column of Table 7 is showing the sample size which is 12 and 12 for Integrity in block chain and Integrity in traditional. For the sake of unbiased results, the sample size in both variables is the same. The 2nd column is showing the range of the data in the block chain and traditional which is

0.5 and 1.00 respectively, the range of both variables are not same in this case the range of Integrity (Traditional) is greater than the Integrity of blockchain which is showing the more variation of Integrity of Traditional as compared to the Integrity of BlockChain. The 3rd column of table 6 includes the minimum values which are 0.5 and 0.00 for Integrity in bock chain and Integrity in traditional respectively, while the maximum values of Integrity in bock chain and Integrity in traditional which are 1.00 and 1.00 respectively, shown in column 4. The mean values of both variables (Integrity in bock chain and Integrity in traditional) are shown in the 5th column of table 7. The mean of Integrity in the blockchain is 0.6875 while the Integrity in traditional is 0.2917. It can be visualized that the mean value of the blockchain is greater than the traditional. The 6th column contains the standard deviation and the 7th column shows the Variance of both variables. The standard deviation of Integrity in the blockchain is 0.21651 and .35086 for Integrity in traditional while the variance of block Chain and traditional is 0.047 and 0.123. The standard deviation and the variance show that the variation of the blockchain is less than the traditional.

**Inferential Analysis**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Score_Integrity | Equal variances assumed | 4.312 | .060 | 3.326 | 22 | .003 | .39583 | .11902 |

**Table 7: Inferential Analysis of Credibility**

For comparing the means of both variables (Blockchain and Traditional), an independent sample t-test has been used and table 8 shows the output of the t-test. Again, before performing the t-test, Levene's test has been applied to check the assumption of the equality of variances, so it can be seen that the P-values of "F" is 0.060, so by the rule of thumb sig. > 0.05, we conclude that the assumption of the equality of variance holds, which means that the variances of both the variables are the same. Table 7 shows that both the groups (blockchain and Traditional) are statistically significantly different because of the Sig. (2 tailed) is <0.05 or it can be said that the P-value 0.003 is less than the alpha value 0.05 so it shows that both the variables are statistically significant. From table 6, the mean of Traceability in the blockchain is 0.6875 while the mean of Traceability in traditional is 0.2917. The mean difference between both the variables is 0.3958 which means that the average of the block chain is 0.3958 points greater than the Traditional. So we can say that the blockchain is better than traditional while considering Integrity as a factor.

H. Charts

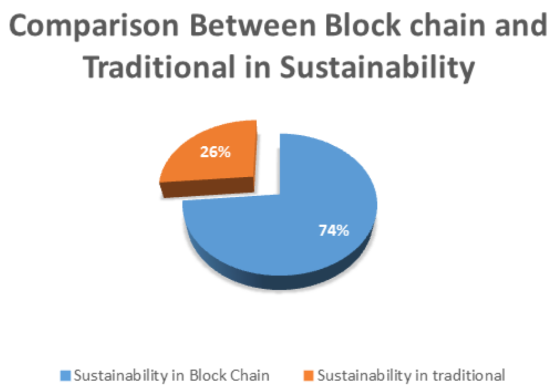


**Figure 3: Sustainability Comparison b/w BlockChain & Traditional**

Sustainability. The above pie chart shows the percentages of the scores obtained by both variables. The blue part shows the Sustainability in BlockChain while the Orange part shows the sustainability in the Traditional variable. By observing the fig. 1 it can be seen that the score of Sustainability in BlockChain is 74% which is higher than the score of sustainability in the Traditional variable which is only 26%. So it can be said that the Blockchain has better performance than the Traditional. In a previous study using the SLR technique author concluded that chosen papers were used to synthesize the present academic literature on blockchain and its ties to traditional supply chains. According to the conclusions of that study, blockchain technology is a potential paradigm for maintaining supply chain operations and blockchain provide sustainable food supply chain (Rejeb and Rejeb 2020). This research proves that the supply chain is more sustainable in blockchain rather than traditional technology by applying the statistical descriptive and inferential test.



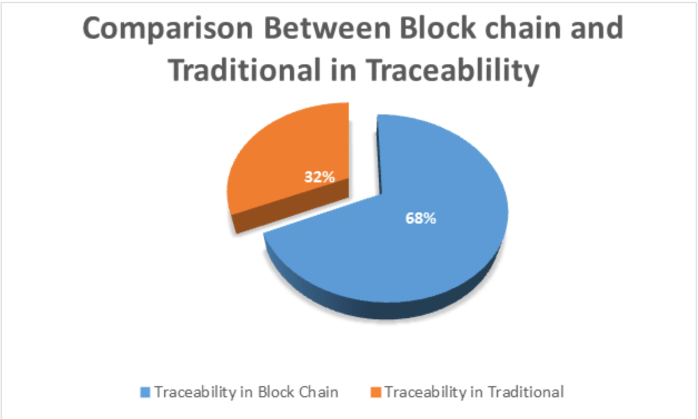


**Figure 4: Traceability Comparison b/w BlockChain & Traditional**

Fig. 4 shows the comparison between Blockchain and Traditional by considering Traceability. The above pie chart shows the percentages of the scores obtained by both variables (BlockChain and Traditional). The blue part shows the Traceability in BlockChain while the Orange part shows the Traceability in the Traditional variable. By observing the fig. 1 it can be seen that the score of Traceability in BlockChain is 68% which is higher than the score of Traceability in the Traditional variable which is only 32%. So it can be said that the Blockchain has better performance than the Traditional. Fragmentation of data, deficiency of transparency caused by data conflicts and instability, lack of interoperability, and a lack of information traceability affect the traditional food supervision system. (Liu et al. 2018).In a previous study by using the SLR methodology author concluded that blockchain is a collection of technologies, tools, and processes that work together to solve a specific problem like traceability because of its decentralized system. Because of its capacity to boost transparency, ensure transaction immutability, and enhance confidence among all food stakeholders, blockchain has garnered considerable favor in the supply chain and logistics community(Rejeb and Rejeb 2020). This research proves that traceability in the blockchain is better than traditional by applying the statistical descriptive and inferential test.

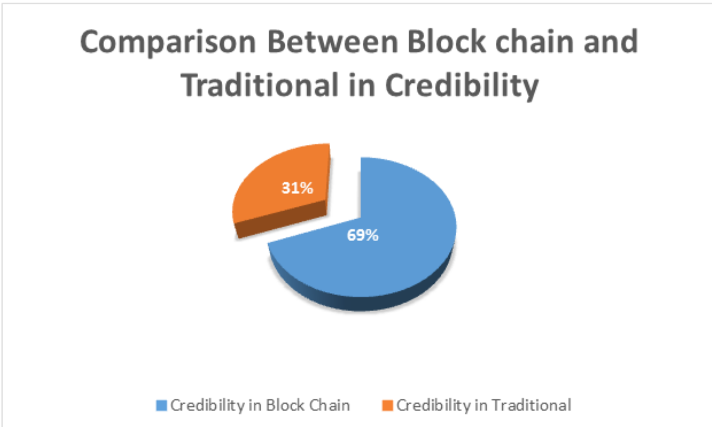


**Figure 5: Credibility Comparison b/w BlockChain & Traditional**

Fig. 5 shows the comparison between Blockchain and Traditional by considering Credibility. The above pie chart shows the percentages of the scores obtained by both variables (BlockChain and Traditional). The blue part shows the Credibility in BlockChain while the Orange part shows the Credibility in the Traditional variable. By observing the fig. 1 it can be seen that the score of Credibility in BlockChain is 69% which is higher than the score of Credibility in the Traditional variable which is only 31%. So the Blockchain has better performance than the Traditional. In a Previous study the author theoretically illustrated that by using SLR methodology, the continuous inefficiencies related to food product transfer from one nation to others can be slightly resolved with blockchain. In this way, blockchain can help to streamline food retailing logistics and distribution, removing information asymmetry and providing a more credible and long-term food trading environment (Rejeb and Rejeb 2020). This research proves that Credibility in the blockchain is better than traditional by applying the statistical descriptive and inferential test.

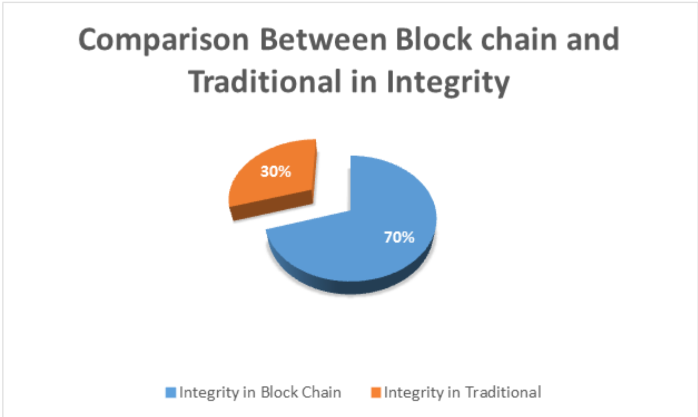


**Figure 6: Integrity Comparison b/w Block Chain & Traditional**

Fig. 6 shows the comparison between Blockchain and Traditional by considering Integrity. The above pie chart shows the percentages of the scores obtained by both variables (BlockChain and Traditional). The blue part shows the Integrity in BlockChain while the Orange part shows the Integrity in the Traditional variable. By observing the fig. 1 it can be seen that the score of Integrity in BlockChain is 70% which is higher than the score of Integrity in the Traditional variable which is only 30%. So the Integrity in Blockchain is better than the integrity in Traditional. In a previous study, the author theoretically illustrated that by using the SLR methodology, blockchain technology provides the benefit of improving the commerce supply chain by simplifying the monitoring system and maintaining the integrity of the information shared. When compared to the local supply chain, blockchain technology work more crucial than the traditional supply chain(Juma, Shaalan, and Kamel 2019). This research proves that Integrity in the blockchain is better than traditional supply chain by applying the statistical descriptive and inferential test.

## I. Conculsion

The current study has been conducted to get the result of competitive analysis with the help of secondary data on the lines of empirical study. In the future, this study should redo on an experimental basis and also check all the variables on the simulations. It also needs to work in the future on other variables which discuss less in the relevant literature. Future researches should combine the food supply chain with data storage and its challenge while utilizing the blockchain in the supply chain. This research has also provided the path to utilize the previous qualitative results and viewpoint of authors on the blockchain bases supply chain. It is also worth doing more statistical analysis i.e. linear regression and multi-regression to get more inter-interactions of all variables. This study has helped all future researches as it collected a large amount of data from previous studies and students have no need to screen previous literature, this study has provided a milestone for previous studies.

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