Blockchain technology characteristics and its impact on improving supply chain performance from the point of view of accounting thought: evidence from Saudi Arabia

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Abstract

This study aimed to clarify the importance of using blockchain in the supply chain sector and test the impact of blockchain technology characteristics on improving supply chain performance by applying it to industrial companies in Saudi Arabia. To achieve this end, the study depended on the inductive approach to prepare the theoretical framework for the study by extrapolating the relevant Arab and foreign scientific studies and research to study and analyze all that is mentioned in the accounting thought about four blockchain characteristics and the impact in improving supply chain performance. It also used the deductive approach, which depends on logical thinking to attempt a logical connection of the relationship between the characteristics of blockchain technology and the performance of supply chains. The statistical approach to conducting the field study with the aim of identifying the trends and opinions of faculty members in the Accounting Department in Saudi universities, accountants in Saudi industrial companies, and information and communications technology experts working in the field of blockchains and the supply chain The sample size was (150) individuals from 2012 until August 2023 to test the impact of the blockchains characteristics on improving the supply chain performance in the Saudi environment. Processing and analyzing study data and conducting statistical tests using the statistical program IBM SPSS Version 29. The study concluded that the importance of using Blockchain technology in improving supply chain performance in Saudi industrial companies, and the presence of a statistically significant effect of the four characteristics of blockchains (transparency and privacy, decentralization, traceability, smart contracts), and the supply chain performance in Saudi industrial companies. The study recommends the following conducting future research in the field of the relationship of Blockchain technology to corporate governance, studying the tax problems of Blockchain operations, and training accountants and workers in industrial companies to deal with Blockchain in a way that is appropriate to their job tasks for improving the supply chain performance and the competitive position of business organizations. Most previous studies have focused on different characteristics of blockchain technology; the present study is the first to focus on four characteristics (Transparency and privacy, Decentralization, Traceability, and Smart Contracts) and examine the relationship between them and the performance of supply chains from the point of view of accounting thought in Saudi industrial companies.

Keywords: Blockchain Technology. Supply Chain. Transparency and Privacy. Decentralization. Traceability. Smart Contracts.
Saudi industrial companies.

1. Introduction

Blockchain technology has gained the attention of all sectors in the digital transformation era. It represents one of the modern and effective technologies that is applied in various fields such as accounting and auditing, finance, financial markets, banks, supply chains, health care, education, energy, and insurance. It is the backbone of supply chain management (Hamdan, et al., 2022) as it gives a comprehensive view of the company's activities and achieves integration between logistical operations within the supply chain, which contributes to developing the strategy of business organizations and increasing business efficiency, and working to provide products with high quality and at an appropriate price value in the proper time, and to provide appropriate data in the proper time, eliminating the complexity of procedures, reducing costs, increasing productivity to increase sales and profits, improving inventory management, delivering products on schedule and with the required quality to meet customer needs and increase their satisfaction, increasing levels of safety, transparency, and protection from counterfeit goods and price manipulation, increasing opportunities for innovation in developing processes and products, and improving operational and financial performance, which contributes to creating value and achieving competitive advantages for companies. (Vida et al., 2019)

The supply chain faces several problems that affect its efficiency, including the difficulty of tracking the supply chain, the difficulty of flowing and sharing data, the asymmetry of information along the supply chain, the problem of real-time delays in customer orders, complexity of supply chain financing operations, a lack of trust between partners, theft, and fraud, delays and increased costs of letters of guarantee, increased shipping costs, the problem of risk management with the presence of a negative impact on the complexity of supply chains during COVID-19 (Xiong et al., 2021), not managing inventory efficiently, not managing reverse flows efficiently, the presence of a communication gap between supply chain parties, Low quality of products and failure to satisfy customer desires (Dnyaneshwar, et al. 2020). To solve these problems, companies must use blockchain technology with the aim of increasing the efficiency of the supply chain. (Sheel, 2020)

The importance of using blockchain in improving the performance of the supply chain from an accounting point of view is that it helps in tracking products along the supply chain, reducing errors that occur during the supply process, and providing products with high quality

and appropriate price value at the right time to achieve a highly competitive advantage for institutions, improving the reputation and brand of companies, improving their operational and financial performance, increasing productivity, profitability, and value creation, discovering opportunities to reduce costs, accounting in real-time, and increasing the level of disclosure and transparency because of exchanging information between the parties of the chain easily, which leads to reducing information asymmetry, tracking inventory levels. And manage it efficiently, reduce transportation time, rationalize the use of resources, maintain ethical standards, and comply with regulatory requirements so that companies can ensure that their products are obtained from ethical and sustainable sources (Kamble, 2020) with the aim of achieving sustainable performance, digitizing and automating supply chain processes and simplifying their procedures using smart contracts. Improving the supervisory role on the performance of all parties within the supply chain, increasing the efficiency of after-sales services such as warranties and maintenance to provide better services to customers and increasing their level of satisfaction, increasing the value of companies through their ability to build new business models and manage risks (Alkhudary, 2022), which in turn is reflected in an increase supply chain efficiency. Aramco, Unilever, and Maersk are among the major companies that use blockchain technology and benefit from it in the field of supply chain management and tracking transactions and products (Tatiana et al., 2022)

From the above, the importance of the subject of the study is clear, which is the impact of the characteristics of blockchain technology on improving the performance of supply chains from the point of view of accounting thought by applying it to industrial companies in the Kingdom of Saudi Arabia, which is considered one of the most important topics that researchers address in their recent studies, and by referring to previous studies in accounting thought. There was a difference in opinions between supporters and opponents of the use of blockchain technology in companies, which prompted the researcher to conduct this study. This is due to clarifying the importance of blockchain technology and knowing the impact of its characteristics on the performance of supply chains. The a lack of accounting studies that are concerned with blockchains because they are one of the Recent topics that are still under research and need further study, so this study is considered additional research in the field of testing the relationship between blockchain technology characteristics and the performance of supply chains due to the increasing need for companies operating in the Saudi market to apply blockchain technology as business solutions specifically designed to serve the supply chain, logistics services and because of their many benefits, especially in increasing the efficiency of supply chain performance considering changing business environments, and the importance of

Saudi companies keeping pace with modern developments in digital technologies and benefiting from them, which supports the vision of the Kingdom of Saudi Arabia 2030 and the application of digital transformation in various fields, Communications, Space & Technology Commission stated in the workshop titled "Blockchain Technology and its Effects on Digital Transformation" that the blockchain market is expected to grow from 2021 to 2025, at a rate exceeding 41%, to exceed the barrier of 100 billion riyals by 2025.

2. Literature Review

2.1. Theoretical background

Blockchain technology is important in the accounting and auditing field, as Deloitte launched the Chains of Trust program for use in the field of accounting and auditing, with the aim of accelerating the processes of reviewing blockchain transactions, improving the efficiency of the supply chain, and increasing customer satisfaction. Blockchain technology affects the future of the accounting and auditing profession (Jennifer and Manlu, 2019). In the accounting field, it works to increase the efficiency of accountants and develop their skills by increasing their ability to understand blockchain technology and how to use it and deal with modern software in the accounting field, which is reflected in the efficiency of the workflow of accounting, and the development of the role of accountants. Instead of conducting traditional accounting operations, they will be largely responsible for the quality of the informational content of financial reports, and the creation of new jobs for them, including reviewing smart contracts, verifying the data and identity of contract parties, reporting on encrypted assets, and arbitration to resolve disputes between participants in the contract (Schmitz, 2019).

The importance of using blockchain technology for the accounting and auditing profession is due to increasing the efficiency of the accounting profession (Andrew Arnold, 2018), by automating accounting transactions, increasing the efficiency of recording accounting operations and ensuring the completion of financial transactions, the inability to modify financial data, which reflects on its protection, and reducing data loss rates. It also works to limit profit management, as blockchain technology provides financial transactions in real-time as they occur, so managers cannot use practices of earning manipulation. The use of blockchain technology affects the speed of financial transactions, reduces the rate of financial errors and fraud in accounting operations, increases audit operations while reducing the costs and fees of accounting and auditing offices because it contains a central ledger that includes

all the data and information necessary for accounting and auditing operations (Bonsón, and Bednárová, 2019), and reduces The cost and time of accessing financial information to stakeholders, verifying the application of accounting rules, efficient selection of the supply chain, increasing the assurance of the security and privacy of the information, and it also helps in activating the target costing method for products by facilitating cooperation between the parties of the supply chain. It also reduces tax evasion and tax compliance by automatically imposing a tax on all financial transactions (Lerer, Mordecai 2019).

The use of blockchain technology increases the accuracy of accounting information, which leads to an increase in the quality of the information content of accounting reports and increases the efficiency and effectiveness of digital financial reports, which in turn is reflected in increased confidence of stakeholders, and more disclosure of non-financial information. It also affects the efficiency of the facility's accounting system in terms of providing reliable data. A study confirmed (Garanina, 2021) that Blockchain technology works to increase the level of disclosure and transparency of financial information and provide it in a timely manner, as Blockchain technology replaces traditional accounting with accounting based on Blockchain technology, which automatically publishes all financial information to stakeholders, which is kept in one central a ledger, so each of them can track the company's transactions and prepare whatever data they need of profitability or financial position.

Blockchain technology also affects auditors and the auditing profession by developing the role of the auditor and expanding the scope of his responsibilities while adding new tasks for auditors. It works to improve the efficiency of the audit process by reducing the time of the audit process and carrying out continuous and comprehensive reviews, reducing errors and risks, and creating trust between the parties to the audit process. And a review of all transactions between reviewers through zero-knowledge protocols that maintain data privacy (Simon et al., 2019). It also affects corporate governance in terms of the difficulty of changing transactions and limiting the ability of managers to profit from illegal transactions. It also affects securities markets by keeping accurate records and providing timely information to investors with transparent stock exchange.

2.2. Blockchain technology and its characteristics from an accounting point of view

Cryptocurrencies are considered the first application of blockchain technology, as they depend mainly on financial transactions and the transfer of ownership between individuals

and institutions without intermediaries. It is defined as a distributed ledger technology or an encrypted information system that relies on a decentralized database that allows all transactions to be recorded as a series of blocks. The new blocks include timestamps and links to previous blocks, so they are a record-keeping system that cannot be changed or hacked and is available to all parties participating in the chain, as define (Hachius and Peterson, 2017) as a peer-to-peer information network, as it involves a decentralized computing system that maintains records of digital transactions through distributed offices to replace traditional databases controlled by governments and banks, as defined by (Chod et al., 2019) as an open-source protocol that uses Bitcoin to provide transparency to the supply chain, and shows the importance of blockchain technology in achieving integration between logistical operations that take place between parties. Supply chains, and to ensure the successful implementation of BCT, the Internet of Things (IoT) must be used to track goods and products, accurately record transaction data, standardize data from different sources, and predictive and prescriptive analyses. The use of blockchain technology contributes to increasing the efficiency of supply chain performance through its various characteristics.

Researchers differed when presenting blockchain characteristics Some specified (Chang, et al. 2022, Kamble, et al. (2020), Sarkar, 2018) the following: anonymity; traceability; autonomy; contract automation; decentralization; immutable, irreversible, Open Source, ownership, and uniqueness, source, security, intelligent execution, and Lin, & Liao, (2017) defined it as a decentralized distributed network, open source network, transparency, records cannot be deleted or modified, efficiency and speed, reducing transaction costs, privacy and anonymity, Real-time, and others have defined it as (Hackius and Peterson, 2017) Security, decentralization, and transparency

Given the many characteristics of blockchain technology, the researcher found that blockchains contain several distinctive characteristics, which can be presented as follows:

- **Transparency and privacy:** Blockchain is an open-source network that helps all participants in the network see all transactions by sharing the ledger among them, which facilitates the flow of information and transactions and increases coordination between stakeholders in sharing information. This makes it an accurate and documented database, so there is no Privacy of information, which increases trust between supply chain parties (Ivaninskiy & Ivashkovskaya, 2022). Blockchain ensures a high degree of transparency and trust in all transactions such as payments, bank transfers, national identity, asset exchange, and others. Also, one of the most important characteristics that distinguishes blockchain technology is privacy,

protecting confidentiality, ensuring the validity of data using algorithms, and not revealing the identity of the user because the chain allows them to use fictitious names and provides security for the data of companies participating in the supply chain. For example, MediConnect created the blockchain platform to provide a single source for prescription data for all pharmacies in the UK.

- **Decentralization:** This property means that there is no central authority to control the system within the network, as it is a decentralized computing system, and therefore the blockchain technology is characterized by being records that cannot be changed, deleted, or modified, as the records on the chain are saved and once verified by all It is difficult for parties to hack or lose, delete or modify data. Therefore, this feature is important because it means verifying that there are no errors in the information or fraud, and it gives the final consumer confidence in the product and ensures safety and consistency in the data, thus increasing the truthfulness of the information.
- **Traceability:** This feature means using records to track the item from the source to the final consumer through the supply chain. Blockchain technology allows mapping and identifying steps in the supply chain, and all parties must agree on procedures and record information at each step of the supply chain process in a Secure and public database, which none of the parties involved can modify or delete This enhances the traceability of every item in the supply chain. Such as tracking supplier information, production process, procurement, and delivery of goods, and in the event of an error, the chain can be traced to discover when and where the problem occurred. Starbucks is working with Microsoft to harness Azure Blockchain to provide real-time digital traceability, so customers can learn more about their coffee beans. Sodhi, Hastig (2019) explained that transparency complements blockchain-based tracking systems rather than replaces them, and it can be said that the use of blockchain tracking technology leads to operational efficiency.
- **Smart Contracts:** Sometimes called Speed and Efficiency. blockchain technology allows organizations to increase automation by creating smart contracts that execute automatically when conditions of pre-defined agreements are met without the presence of intermediaries. It is applied to supply chain management, so transactions are characterized by speed, efficiency, and low transaction costs, as the technology contributes to the speed of executing transactions and efficiency in settling transactions compared to traditional systems, which may require manual review and auditing, especially cash assets. It also reduces the risk of non-payment and could secure financing terms and costs; PepsiCo has used smart contracts resulting in a 28% increase in efficiency (Roberto, 2018).

Blockchain technology plays an important role in supply chain management by providing information on demand forecasts, managing resources effectively, reducing inventory management costs, and tracking and monitoring goods along the supply chain. In adverse circumstances, this technology helps in accurately identifying the cause and source, and automatically activates payments after validating pre-defined conditions (Yadlapalli and

Rahman, 2022). Song et al. (2019) opined that Blockchain technology represents a good system for tracking the supply chain through its various characteristics, but the technology faces several challenges, including the need for large investments to connect physical and non-digital elements to the digital space, convincing stakeholders of the decentralized network, and lack of trust of people to approve of this technology. The study (Chavalala et al., 2022) confirmed that there are major obstacles to the implementation of blockchain technology in the supply chain, the most important of which is the weak leadership style of senior management, as the fate of developing the infrastructure for blockchain technology depends on the leadership style of senior management. A good leader can guide the entire team to improve IT governance, and financial investment, collaborate with service providers to implement blockchain, help the team overcome the fear of implementing blockchain in the supply chain, and focus on security and privacy policies. Chang, et al. (2022) confirmed there are challenges related to confidentiality. Although users are anonymous, private information may leak in one way or another, challenging stability and ensuring data integrity. However, it imposes restrictions on business applications, especially when there are returns for goods and refunds of money, and the problem of the information in the blockchain being incorrect. This is completely due to errors that may appear at the stage of entering data for the first time into the system. As for the challenges facing the Saudi market, they are the lack of sufficient maturity of the technology, whether in the global or local markets, lack of clarity in the laws for using the technology, lack of experience and experts to apply the technology, lack of industry participation (Chaouni et al., 2023), high infrastructure costs, weakness Support from senior management, lack of sufficient awareness of the importance of applying blockchain technology to the labor sector in particular (Monshaat, 2022).

2.3. Supply chain management and measured

The supply chain is defined as the process of the flow of materials, money, and information from suppliers to the final consumer, it is called a value chain, so it is defined as a group of activities that add value across multiple companies to satisfy the needs of the final consumer, while supply chain management is defined as managing the flow of goods, data, and related funds with products or services, from purchasing raw materials to delivering the product to the final consumer. The objectives of the supply chain are to improve long-term performance in the supply chain, reduce costs along the supply chain, increase profitability in the long term, provide products and services at the appropriate price and quality and in the

proper time, manage the flow of raw materials efficiently within the supply chain to ensure they reach customers in the proper cost in a timely manner, resolving the problem of conflict of interest between members of the supply chain, achieving competitive advantage for companies, and meeting customer needs.

The supply chain efficiency increases by achieving and improving its goals, so any business with a supply chain must manage all suppliers, manufacturers, consumers, and logistics parties accurately and quickly. But nowadays supply chains have become more complex and lack transparency and speed due to market globalization, so maintaining the efficient performance of supply chains has become difficult, and applying blockchain in supply chain management has become very important Benjamin et al. 2020). Companies seek to improve the efficiency of the supply chain through several factors, including reducing transaction costs and producing products with the required quality, speeding the flow of products and information to maximize the added value of the products, and increasing responsiveness to customers' desires, providing high-quality products at an appropriate price value, which contributes to achieving competitive advantages for companies. Activating the supervisory role on the performance of all parties within the supply chain, exchanging information and electronic data, managing the organization's internal operations efficiently, successfully managing the risks facing the supply chain in periods of uncertainty, increasing transparency for all parties of the supply chain and sharing information, so there is no room for delaying the delivery of products and then reducing delay costs, providing financial and non-financial information and sharing it accurately and in a timely manner to all parties of the supply chain to improve cooperation between supply chain parties, relying on information which increases trust and transparency among all parties of the supply chain, increasing financial performance represented in the volume of revenues and sales volume, and reducing Product life cycle time and improved inventory management, which is reflected in a decrease in the cost of products and an increase in the market share of companies(Kummer et al.,2020).

Supply chain performance is measured through several criteria, including cost and speed of supply, quality of performance, customer satisfaction, quality, and appropriate timing of supply (Nezih Altay et al., 2023). Supply chain performance refers to the overall performance measure that depends on the efficiency of the supply chain stages, so it can be said that one of the dimensions of supply chain performance is efficiency. Efficiency refers to the ratio of outputs to inputs. To increase efficiency, companies must achieve the highest possible performance and reduce costs, given that organizations have limitations in achieving competitive advantage. Efficiency is achieved by improving and achieving supply chain

objectives in a manner Public by activating the features of decentralization, transparency, tracking, and programming. Therefore, blockchain technology, through its characteristics, contributes to achieving the objectives of the supply chain and thus increasing its efficiency (Hald and Kinra, 2019). Examples of companies that have applied blockchain technology to manage supply chains in China include Blockchain technology with RFID technology in building the agricultural food supply chain (Dickinson, 2018), and the technical company Chain Ship has developed a supply chain management system based on Blockchain technology to monitor its activity in logistics services. The Navy tracks goods from the moment they are manufactured until they leave the factory and reach the final consumer (Tijan, et al., 2019)

2.4 The impact of Blockchain technology characteristics on supply chain performance

2.4.1 Transparency and privacy

This feature enhances the level of transparency for all transactions compared to traditional systems, as it is an open-source network that enables all parties in the supply chain to see all data and transactions, and any changes are made only with the approval of all parties. This in turn is reflected in increasing the level of transparency and trust between the entities participating in the supply chains and consumers, and providing Data, identifying, and identifying cost causes, and discovering cost opportunities. This feature facilitates the flow of information between all parties of the chain easily and quickly access it when needed and enables companies to manage risks, sustain supply chains, and increase customer confidence as a result of increasing their awareness about the quality and safety of products and increasing the facility's interaction with all parties of the supply chain, including suppliers, producers, customers, and distributors, in a way that enhances levels of performance and quality, and shares resources and information and their flow from supplier to customer in real-time while simplifying procedures for production activities, and allows accountants to access the network and collect data on all activities, customers, suppliers, distributors, wholesalers, and retailers across the supply chain. Privacy also affects the performance of supply chains, as it builds security and trust between supply chain parties and reduces risks by maintaining data privacy and not revealing the identity of the user (Zhang, et al. 2019), so the researcher believes that the transparency and privacy feature of blockchains leads to improving supply chain performance as it creates an efficient and more transparent supply chain.

2.4.2. Decentralization

This feature provides a decentralized database that maintains records of digital transactions through distributed offices without the need for an intermediary from the financial market or the bank, which helps accountants verify the accuracy of the data and that it is free from any fraud or error and thus increasing the truthfulness of the information. Decentralization eliminates individual weak points from the use of central systems in terms of monopolizing the storage and management of data (Dhillon et al., 2023). As a result of the lack of central authority to control the system within the network and the availability of a verifiable record of every financial transaction, people within the network can authenticate and verify the transactions. This feature facilitates cooperation between entities. It is effective and verifies the origin of the goods and the conditions of their transfer until they reach the final consumer, which contributes to reducing hacking and loss of data. It also helps accountants in verifying financial transactions and ensuring their authenticity and that there is a sufficient balance of funds with the sender to complete the transaction, which contributes to increasing confidence in the transactions that take place on the length of the supply chain, so researcher believes that decentralization feature of blockchains lead to improving supply chain performance.

2.4.3. Traceability

The importance of the traceability feature appears when applying blockchain technology in supply chain management, as traceability can ensure the safety of operations by tracking illustrative maps stored on the blockchain network and tracking the product, which contributes to saving resources, scheduling production, tracking the progress of goods as they pass through the supply chain, and delivering the product with high quality in a timely manner to achieve customer satisfaction (Mukherjee et al., 2023), this feature provides participants in the supply chain with accurate and stable financial and non-financial data about the company's activities and how to exploit resources, verifying the safety and quality of the product from its source until it reaches the final consumer, and forecasting demand in the market and supporting production decisions (Liu, 2023), tracking supply chain quality eliminates fraud risks, prevents adulteration of products, identifies production defects and addresses them, and increases operational efficiency, which contributes to creating added value for organizations. Tracking helps accountants support the value chain analysis method

between the parties of the chain (Tang et al. 2018), activating the target costing method, determining the costs and revenues achieved from the facility's activities, and activating inter-cost management tools, traceability also eliminates unethical practices of stakeholders, which supports the coordination and integration of the supply chain. Therefore, the researcher believes that the traceability feature of blockchains leads to improving supply chain performance.

2.4.4. Smart Contracts

Smart contracts and the use of Bitcoin encrypted currencies reduce costs, increase the speed of commercial transactions, speed up import and export operations because of instant payments, and reduce errors by concluding programmed contracts, as they are executed automatically when conditions are met pre-specified agreements without intermediaries such as a bank compared to traditional systems. It also eliminates the slowness of traditional banking systems when settling financial transactions, which require manual auditing, especially cash assets, and eliminates the additional expenses paid to intermediaries to complete transactions. It helps accountants in verifying the commitment of all parties to the costs and continuous monitoring of them, such as purchase costs and costs of delay in delivery, which results in increased profits and thus increases profits. Supply chain transactions become more convenient and at a lower cost, enabling companies to contract on product specifications, price, delivery times, and related logistical costs while simplifying payment methods, lowering the cost of transactions, reducing letters of guarantee, and securing the financing condition, eliminating fraud and contract manipulation and reducing the risk of non-payment as done payment electronically using digital currencies, once the contracting process is completed and the goods are transferred with the required specifications and quality, it helps accountants reduce costs through inventory management and reduce non-value-added activities such as promotion, distribution, transportation, handling, and storage. Therefore, the researcher believes that the smart contracts feature of blockchains leads to improving the supply chain performance.

From the theoretical part above, it becomes clear to the researcher the importance of blockchain technology in the supply chain sector, as it contributes, through its various characteristics, to increasing the efficiency of supply chain performance. Figure 1 illustrates the relationship between blockchain technology characteristics and supply chain performance.

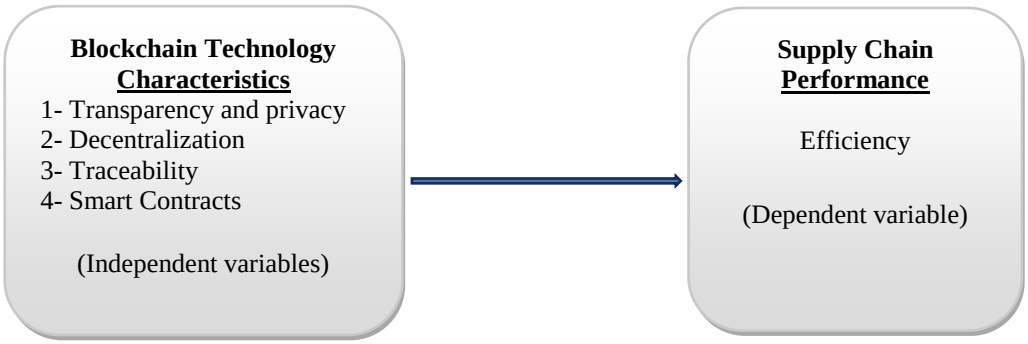


Figure 1: The relationship between blockchain technology characteristics and supply chain performance

Based on the above literature review, the study's hypotheses can be formulated as follows:

H01: There are not a statistically significant differences between the study sample's opinions about the importance of using blockchain technology in supply chains in Saudi industrial companies.

H02: There is not a statistically significant impact of blockchain technology characteristics on supply chain performance in Saudi industrial companies.

H03: There are not a statistically significant differences between the study sample's opinions about the impact of blockchain technology characteristics on the supply chain performance in Saudi industrial companies.

3. Empirical Methodology

The study aims to identify the trends and opinions of faculty members in the Accounting Department in Saudi universities, accountants in Saudi industrial companies, and information and communications technology experts working in the field of blockchains and the supply chain to test the impact of the blockchains characteristics on improving the supply chain performance in the Saudi environment.

3.1. The study data and sample

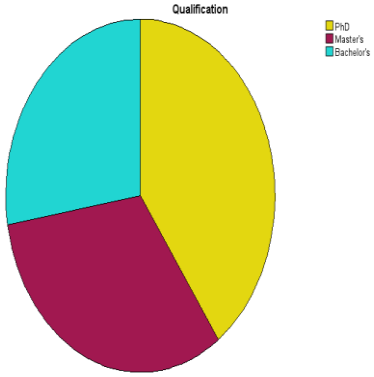
The study population consists of faculty members in the Accounting Department in Saudi universities, accountants in Saudi industrial companies, and information and communications technology experts who work in the field of blockchains and supply chains. Due to the large size of the study population, the researcher selected an estimated sample of (150) individuals from 2012 until August 2023. The field study community was chosen so that its members had scientific and practical experience, and the industrial joint stock companies listed on the Saudi stock market were chosen because they are among the most active sectors and among the basic pillars of the Saudi economy, which are expected to grow in the future, especially with the launch of the "National Industrial Development and Logistics Services Program." Within Saudi Vision 2030, this necessitates that this sector be managed efficiently and effectively commensurate with the size of the challenges related to supply chain performance, which requires companies to redouble their efforts to achieve the targeted performance levels. Therefore, rational corporate management must use the most modern and effective technologies to meet supply chain requirements. The researcher relied on a questionnaire form to collect data with the aim of testing the study hypotheses. The statistical program IBM SPSS Statistics Version 29 was used. Before distributing the questionnaire to the study sample, it was reviewed by arbitrators from Saudi university professors who specialize in this field, and deletions, modifications, and additions were made. The questionnaire list items were selected according to the opinions of the arbitrators to reach the final form of the questionnaire. A five-point Likert scale was used when designing the survey form. As shown in Table 1, the correct questionnaires reached (112) with a response rate of 74.7%, which is an acceptable percentage for conducting statistical analysis.

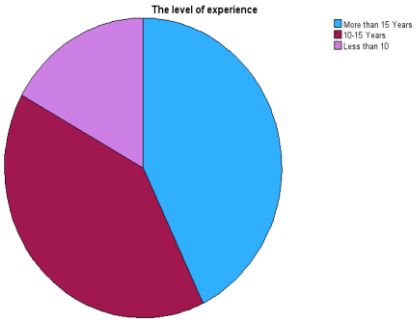
Table 1: Collecting questionnaire forms for the study.

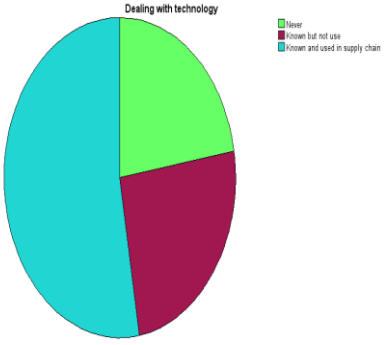
Categories	**Total number of forms**			**Percentage %**
	Feedback	Received	Distributed	
Faculty members in Saudi universities	10	40	50	%80
Accountants in Saudi industrial companies	12	38	50	%76
ICT experts	16	34	50	%68
Total	**38**	**112**	**150**	**%74.7**

Table 2: Distribution of the study sample according to academic qualification and years of experience, and description of companies' dealings with blockchain technology.

Categories		Description of the sample's interaction with block chain technology			Level of experience in practicing the profession			Qualification		
		The sample relies on block chain technology in supply chain	The sample is aware of blockchain technology but has not used it	The sample has no knowledge of block chain technology	5 years and less	More than 10 years and less than 15 years	More than 15	Bachelor's degree	Master	PhD
Faculty members	No.	40	0	0	3	10	27	3	8	29
	%	100	0	0	7.5	25.0	67.5	7.5	20	72.5
Accountants	No.	21	11	6	8	24	6	20	11	7
	%	55.3	28.9	15.8	21.1	63.2	15.8	52.6	28.9	18.4
ICT experts	No.	21	8	5	8	11	15	8	17	9
	%	61.8	23.5	14.7	23.5	32.4	44.1	23.5	50.5	26.5
Total	**No.**	**82**	**19**	**11**	**19**	**45**	**48**	**31**	**36**	**45**
	%	**73.2**	**17.0**	**9.8**	**17.0**	**40.2**	**42.9**	**27.7**	**32.1**	**40.2**







When reviewing the first section of the survey lists, it was found that the academic qualification of the respondents was the largest percentage of PhD holders, 40.2%. I also found that the highest percentage of years of experience was for those with more than 15 years of experience, representing 42.9%, which gives reassurance to the level of experience of the interviewee. It was also found that 42.0% of accountants and experts relate their companies' interest in the topic of Blockchain to the reality of work and its relationship to supply chains, and 100% of academics relate to it from the reality of scientific interest and

scientific research, which covers the various aspects of research and gives reassurance of the realism of the data.

3.2. Study variables

The questionnaire was designed in the form of three questions, and the researcher measured each variable using (41) sub-questions, these variables were summarized as follows: (The abbreviations used are explained in Appendix 1.)

The first variable (Z1): It is represented by the first question, which shows the importance of blockchains, and consists of questions from X1 to…...X10.

The second variable (Z2): It is represented by the second question, which shows the impact of the blockchain characteristics on the supply chain performance and consists of questions from X11 to....X32.

The third variable (Z3): It is represented by the third question, which shows the supply chain performance, and consists of questions from Y1 to...Y9.

4. Discussion of the Results

4.1 Reliability and validity coefficients

By reviewing Table No. 3, the value of Cronbach's alpha coefficient was high for all variables of the survey form by sample and greater than 70%, and the value of self-reliability for all variables was greater than 90%, so can be relied upon in generalizing the results to society.

Table 3: Reliability and validity coefficients for survey questionnaire questions

Statement	No. of items	Reliability coefficient (Cronbach's alpha)			Honesty coefficient		
		Academics	Accountants	Experts	Academics	Accountants	Experts
The importance of using blockchain technology in supply chains	10	0.733	0.852	0.913	0.856	0.923	0.956
The impact of block chain characteristics on supply chain performance	22	0.818	0.839	0.844	0.904	0.916	0.919
Factors that lead to improved supply chain performance	9	0.765	0.718	0.715	0.875	0.847	0.846
Questionnaire form variables	**41**	**0.823**	**0.904**	**0.903**	**0.907**	**0.951**	**0.950**

4.2. Smironoff-Kilmogrove test

Table 4 shows the Smironoff-Kilmogrove test which is considered one of the statistical tests that are used to examine the collected data to see whether it is normally distributed or not. It is a necessary test in the case of testing hypotheses because most laboratory tests require that the distribution of data be normal, and the researcher obtained the following results:

Table 4: Results of the Smironoff-Kilmogrove test for one sample

Variables		Z_1	Z_2	Z_3
N		112	112	112
Normal Parameters	Mean	4.2867	4.316	4.313
	Std. Deviation	0.514	0.429	0.427
Kolmogorov-Smirnov Z		0.170	0.150	0.128
Asymp. Sig. (2-tailed)		0.001	0.001	0.001

It is clear from the above table that the significance level of Z1, Z2, Z3 is less than the significance level (α>0.05), and this indicates that the data follows a normal distribution.

4.3. The results of the first hypothesis

H01: There are not a statistically significant differences between the study sample's opinions about the importance of using blockchain technology in supply chains in Saudi industrial companies.

To test the first hypothesis, descriptive tests were conducted for the variables and an ANOVA test was conducted for unequal samples.

Table 5: Results of descriptive tests for the variables

Z1	Academics			Accountants			Experts		
	Mean	Std. eviation	anking	Mean	Std. eviation	anking	Mean	Std. eviation	anking
X1	4.20	.687	3	4.18	.563	1	4.97	.171	4
X2	4.02	.577	7	3.79	.704	7	4.94	.239	9
X3	4.00	.641	8	4.03	.283	5	5.00	.000	1
X4	4.20	.687	2	3.63	.633	10	4.94	.239	6
X5	4.03	.276	6	4.03	.283	4	4.97	.171	3
X6	4.00	.506	9	3.71	.565	9	4.91	.288	10

X7	3.87	.463	10	4.08	.487	3	4.97	.171	2
X8	4.10	.496	4	3.76	.751	8	4.94	.239	8
X9	4.08	.829	5	4.11	.388	2	4.94	.239	5
X10	4.28	.679	1	3.79	.622	6	4.94	.239	7

Source: results of statistical analysis.

Table 5 shows clearly that the sample members agreed on the importance of using blockchain technology in supply chains in Saudi industrial companies, as the arithmetic mean ranged between (3.63 - 5.00) and the standard deviation for the opinions of the study sample ranged between (0.239 - 0.829).

Table 6: Results of the ANOVA test to compare means between three unequal groups.

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Academic	40	4.08	.283	.045	3.99	4.17	3	5
Accountant	38	3.91	.301	.049	3.81	4.01	4	5
Experts	34	4.95	.131	.022	4.91	5.00	4	5
Total	**112**	**4.29**	**.514**	**.049**	**4.19**	**4.38**	**3**	**5**

Source: results of statistical analysis.

ANOVA

Groups	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	22.220	2	11.110	171.763	.001
Within Groups	7.050	109	.065		
Total	**29.270**	**111**			

Source: results of statistical analysis.

We note that the significance value of 0.001 is less than 0.05, which indicates that the null hypothesis is rejected, and we accept the alternative hypothesis “There are a statistically significant differences between the study sample's opinions about the importance of using blockchain technology in supply chains in Saudi industrial companies", in favor of the group of experts because it is the highest arithmetic average of 4.95.

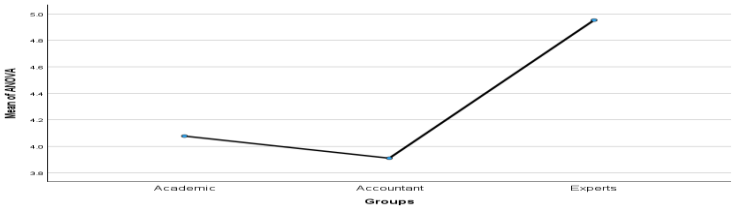


Figure 1: Means Plots

4.3. The results of the second hypothesis

H02: There is not a statistically significant impact of blockchain technology characteristics on supply chain performance in Saudi industrial companies.

It is divided into 4 sub-hypotheses as follows:

H02.1: There is not a statistically significant impact of the characteristics of blockchains (Transparency and Privacy) on improving supply chain performance in Saudi industrial companies.

H02.2: There is not a statistically significant impact of the characteristic of blockchains (Decentralization) on improving supply chain performance in Saudi industrial companies.

H02.3: There is not a statistically significant impact of the characteristic of blockchains (Traceability) on improving supply chain performance in Saudi industrial companies.

H02.4: There is not a statistically significant impact of the characteristics of blockchains (Smart Contracts) on improving supply chain performance in Saudi industrial companies.

To test the second hypothesis, descriptive tests of the variables and simple linear regression analysis were conducted.

Table 7: Results of descriptive tests for the variables

X (Independent variable) / Y (Dependent Variable)			Academics				Accountants				Experts			
			Mean	Std. Deviation	Std. Error	Ranking	Mean	Std. Deviation	Std. Error	Ranking	Mean	Std. Deviation	Std. Error	Ranking
X	XC1	X11	4.23	.480	.076	1	4.18	.393	.064	2	4.94	.239	.041	3
		X12	4.05	.316	.050	4	3.68	.574	.093	6	4.88	.327	.056	4
	Transparency	X13	4.10	.545	.086	2	4.18	.393	.064	1	4.97	.171	.029	1

	and Privacy	X14	3.98	.423	.067	6	3.84	.754	.122	5	4.88	.409	.070	5
		X15	4.10	.441	.070	3	4.08	.428	.069	3	4.85	.436	.075	6
		X16	4.00	.392	.062	5	3.87	.578	.094	4	4.94	.239	.041	2
	XC2 Decentralization	X17	4.13	.404	.064	2	4.05	.324	.053	2	4.94	.239	.041	2
		X18	3.88	.822	.130	5	3.76	.490	.079	5	4.94	.239	.041	5
		X19	3.90	.496	.078	4	4.03	.367	.059	3	4.94	.239	.041	4
		X20	4.00	.392	.062	3	3.89	.727	.118	4	4.97	.171	.029	1
		X21	4.20	.516	.082	1	4.18	.457	.074	1	4.94	.239	.041	3
	XC3 Traceability	X22	4.35	.533	.084	2	3.76	.634	.103	5	4.94	.239	.041	3
		X23	4.43	.594	.094	1	4.13	.343	.056	2	4.97	.171	.029	1
		X24	4.23	.660	.104	4	3.92	.749	.122	4	4.59	.500	.086	5
		X25	4.20	.687	.109	5	4.05	.399	.065	3	4.94	.239	.041	2
		X26	4.32	.656	.104	3	4.18	.801	.130	1	4.91	.379	.065	4
	XC4 Smart Contracts	X27	4.25	.494	.078	3	4.11	.453	.073	2	4.79	.479	.082	5
		X28	4.37	.586	.093	2	3.87	.665	.108	4	4.94	.343	.059	1
		X29	4.17	.594	.094	5	4.13	.414	.067	1	4.91	.379	.065	2
		X30	4.17	.781	.123	4	3.79	.622	.101	5	4.82	.459	.079	4
		X31	3.93	.944	.149	6	3.92	.487	.079	3	4.85	.500	.086	3
		X32	4.58	.501	.079	1	3.71	.654	.106	6	4.59	.500	.086	6
Y Supply Chain Performance (Efficiency)		Y1	4.23	.660	.104	5	3.92	.749	.122	6	4.59	.500	.086	8
		Y2	4.20	.687	.109	6	4.05	.399	.065	4	4.79	.479	.082	5
		Y3	4.32	.656	.104	3	4.18	.801	.130	1	4.82	.387	.066	4
		Y4	4.25	.494	.078	4	4.11	.453	.073	3	4.79	.479	.082	6
		Y5	4.37	.586	.093	2	3.87	.665	.108	7	4.97	.171	.029	1
		Y6	4.17	.594	.094	8	4.13	.414	.067	2	4.82	.576	.099	3
		Y7	4.17	.781	.123	7	3.79	.622	.101	8	4.79	.479	.082	7
		Y8	3.93	.944	.149	9	3.92	.487	.079	5	4.85	.436	.075	2
		Y9	4.58	.501	.079	1	3.71	.654	.106	9	4.56	.504	.086	9

Table 7 shows is clear that most opinions range from important to very important about the impact of blockchain technology characteristics on improving the supply chain performance in Saudi industrial companies, where the arithmetic mean ranges between (3.76 - 4.97) and the standard deviation of the opinions of the study sample ranges between (0.171 - 0.944).

The sub-hypotheses were tested through simple linear regression analysis for each hypothesis separately.

Table 8: Results of simple linear regression analysis for the data.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	F	Sig.	Collinearity Statistics		Results
		B	Std. Error	Beta					Tolerance	VIF	
H02.1	Constant	1.399	.238		5.866	.001	151.114	.000			Reject

	XC1	.678	.055	.761	12.293	.000			1.000	1.000	
		R = .761			R Square = .579			Adjusted R Square = .575			
H02.2	Constant	1.557	.251		6.193	.001	121.673	.000			Reject
	XC2	.642	.058	.725	11.031	.000			1.000	1.000	
		R = .725			R Square = .525			Adjusted R Square = .521			
H02.3	Constant	.602	.185		3.248	.002	404.606	.000			Reject
	XC3	.848	.042	.887	20.115	.000			1.000	1.000	
		R = .887			R Square = .786			Adjusted R Square = .784			
H02.4	Constant	.488	.114		4.287	.001	1139.218	.000			Reject
	XC4	.887	.026	.955	33.752	.000			1.000	1.000	
		R = .955			R Square = .912			Adjusted R Square = .911			

Table 8 shows the results of the simple linear regression analysis for the first sub-opportunity H02.1, we find that the value of the correlation coefficient is R=761. This indicates the existence of a high direct relationship between the transparency and privacy characteristic of blockchains (XC1) and the performance of the supply chain (Y) in the Saudi industrial sector, and this characteristic can explain a percentage of 58% of the change in supply chain performance, where the value of the coefficient of determination R = 0.575, and the value of sig. It is 0.000, which is less than 0.01, and this indicates that there is a statistically significant effect of the transparency and privacy of blockchains on improving the performance of the supply chain. Therefore, we reject the null hypothesis and accept the alternative hypothesis: “There is a statistically significant impact of the Transparency and Privacy characteristics of blockchains on improving supply chain performance in Saudi industrial companies”.

Regarding the second sub-opportunity H02.2, we find that the value of the correlation coefficient is .725 = R. This indicates the existence of a high direct relationship between the decentralization characteristic of blockchains (XC2) and the performance of the supply chain (Y) in the Saudi industrial sector, and the decentralization characteristic of blockchains can explain 78% of the change the outcome in supply chain performance, where the value of the coefficient of determination R =.784, and the value of sig. It is 0.000, which is less than 0.01, and this indicates that there is a statistically significant effect of the decentralization of blockchains on improving the performance of the supply chain. Therefore, we reject the null hypothesis and accept the alternative hypothesis: “There is a statistically significant impact of the decentralization characteristic of blockchains on improving supply chain performance in Saudi industrial companies”.

Regarding the third sub-opportunity H02.3, we find that the value of the correlation coefficient is .887 =R. This indicates the existence of a highly direct relationship between traceability blockchains (XC3) and supply chain performance (Y) in the Saudi industrial sector. The feature of tracking blockchains can explain 78% of the change that occurred in supply chain performance, the value of the coefficient of determination R = .784, and the value of sig. It is 0.000, which is less than 0.01, and this indicates that there is a statistically significant effect of traceability blockchains on improving the performance of the supply chain. Therefore, we reject the null hypothesis and accept the alternative hypothesis: "There is a statistically significant impact of the traceability characteristic of blockchains on improving supply chain performance in Saudi industrial companies".

Regarding the third sub-opportunity H02.4, we find that the value of the correlation coefficient is .955 = R. This indicates that there is a very high direct relationship between smart contracts for blockchains (XC4) and the performance of the supply chain (Y) in the Saudi industrial sector. Smart contracts for blockchains can explain 91% of the change in supply chain performance, where the value of the coefficient of determination R = .911, and the value of sig. It is 0.000, which is less than 0.01, and this indicates that there is a statistically significant effect of smart contracts for blockchains on improving the performance of the supply chain. Therefore, we reject the null hypothesis and accept the alternative hypothesis: "There is a statistically significant impact of the Smart Contracts characteristics of blockchains on improving supply chain performance in Saudi industrial companies".

Using multiple regression to test the second main hypothesis with the aim of measuring the relationship between the independent variables (characteristics of the four blockchains) XC1, XC2, XC3, XC4 and the dependent variable Y (supply chain performance represented by efficiency), Table 9 shows the following results.

Table 9: Results of the Pearson correlation matrix.

Correlations						
		Y	XC1	XC2	XC3	XC4
Pearson Correlation	Y	1.000	.761	.725	.887	.955
	XC1	.761	1.000	.866	.799	.770
	XC2	.725	.866	1.000	.777	.715
	XC3	.887	.799	.777	1.000	.808
	XC4	.955	.770	.715	.808	1.000
Sig. (1-tailed)	Y	.	.001	.001	.001	.001

	XC1	.000	.	.000	.000	.000
	XC2	.000	.000	.	.000	.000
	XC3	.000	.000	.000	.	.000
	XC4	.000	.000	.000	.000	.
N	Y	112	112	112	112	112
	XC1	112	112	112	112	112
	XC2	112	112	112	112	112
	XC3	112	112	112	112	112
	XC4	112	112	112	112	112

The previous table shows the correlation matrix between the variables of the multiple regression model, where the Pearson correlation coefficient was the highest between Y and the correlations between the dependent variable and the independent variables are positive and statistically significant.

Table 10: Results of the multiple regression analysis to test the significance of the model.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	Constant	.203	.091		2.229	.028		
	XC1	-.090	.042	-.101	-2.138	.035	.351	2.849
	XC2	-.007	.038	-.008	-.182	.021	.231	4.336
	XC3	.370	.039	.387	9.393	.000	.255	3.929
	XC4	.674	.035	.725	19.222	.000	.304	3.289
	R = .977							
	R Square = .954			Adjusted R Square = .952				
	F = 550.86			Sig. = .000				
	VIF Less than 5, it means there is no problem of multicollinearity between the variables and the results are reliable.							
	Level of statistical significance 5%							

a. Dependent Variable: Y

Table 10 shows the analysis of the results of the multiple linear regression for the second main hypothesis, it appears that there is a strong correlation between the dependent variable and the independent variables, as the correlation coefficient reached the value of R (0.977), the value of the coefficient of determination (0.925), and the value of the coefficient of determination of the rate (0.952), meaning that the independent variables XC1, XC2, XC3,

XC4 (characteristics of blockchains) It explains about 95% of the change in the dependent variable Y (supply chain performance), which is a very high percentage. We note that the values of the variance inflation rate (VIF) range between (1-5) and this indicates that there is no linear interference between the independent variables. Maddala 1992 stated that the values of the VIF are better to be less than 5 and greater than 1.

From the results of the ANOVA analysis to test the significance of the multiple regression, we note that the value of sig. It is 0.000, which is less than 0.01. This means that the regression is significant, and the model is statistically significant, and therefore there is an effect of the independent variables XC (characteristics of blockchains) on the dependent variable Y (improving supply chain performance). Therefore, we reject the null hypothesis and accept the alternative hypothesis: "There is a statistically significant impact of the blockchains characteristics on supply chain performance in Saudi industrial companies.

The previous table No.10 helps extract the following regression equation:

$$Y = 0.203 - 0.090\ XC1 - .007\ XC2 + 0.370\ XC3 + 0.674\ XC4$$

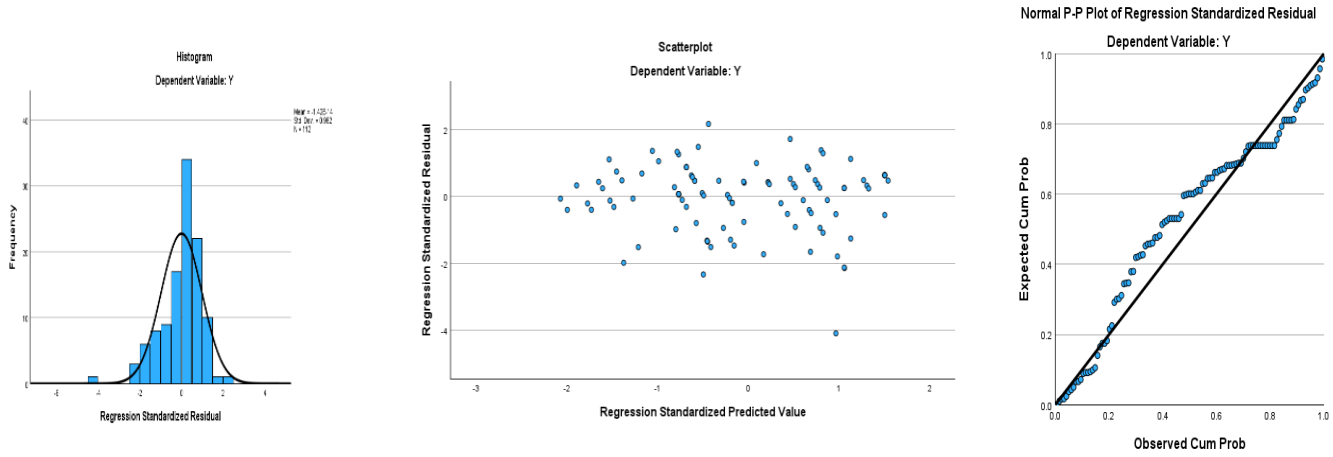


Figure 2: Distribution of residuals

The previous figures show the normality of the distribution of the residuals and the collection of data around the straight line. Therefore, the residuals follow a normal distribution, which is one of the conditions for the validity of conducting regression analysis.

4.3. The results of the third hypothesis

H03: There are not a statistically significant differences between the study sample's opinions about the impact of blockchain technology characteristics on the supply chain performance in Saudi industrial companies.

To test the third hypothesis, descriptive tests were conducted for the variables and the Scheffe unequal samples ANOVA test.

Table 11: Results of descriptive tests for the variables

Descriptive Statistics				
	Mean	Std. Deviation	Std. Error	N
Y	4.3125	.42697	.04034	112
XC1	4.2946	.47877	.04524	112
XC2	4.2893	.48162	.04551	112
XC3	4.3768	.44661	.04220	112
XC4	4.3095	.45950	.04342	112

The previous table 11 shows the descriptive statistics for the variables of the multiple regression model, where the sample size is 112, the arithmetic means follow a five-point Likert scale, so they are less than 5, and the standard deviations are.

Table 12: Results of the ANOVA test to compare means between three unequal groups (Scheffe Test)

Descriptives								
Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	40	4.19	.178	.028	4.13	4.24	4	5
2	38	3.97	.258	.042	3.88	4.05	3	5
3	34	4.85	.151	.026	4.80	4.91	4	5
Total	112	4.32	.420	.040	4.24	4.39	3	5

ANOVA					
Groups	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	15.096	2	7.548	184.543	.001

Within Groups	4.458	109	.041		
Total	19.555	111			
The mean difference is significant at the 0.05 level.					

We note that the significance value of 0.001 is less than 0.05, which is greater than the tabular value, which indicates that the null hypothesis is rejected, and we accept the alternative hypothesis, which assumes that "There are statistically significant differences between the study sample's opinions about the impact of blockchain technology characteristics on the supply chain performance in Saudi industrial companies", in favor of the group of experts because it is the highest arithmetic average 4.85.

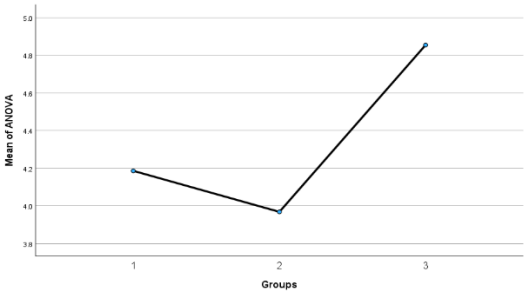


Figure 3: Means Plots

5. Conclusions, Recommendations, and Future Studies

The study investigated the relationship between blockchain technology characteristics and the supply chain performance in Saudi industrial companies, The researcher conducted a field study of (150) individuals from 2012 until August 2023. The community was chosen by faculty members in the Accounting Departments in Saudi universities, accountants in Saudi industrial companies, and information and communications technology experts in the industrial joint stock companies listed on the Saudi stock market. The results of the study showed the importance of using Blockchain technology in improving supply chain performance in Saudi industrial companies, and the presence of a statistically significant

effect of the four characteristics of blockchains (transparency and privacy, decentralization, traceability, smart contracts), and the supply chain performance in Saudi industrial companies, and also the existence of statistically significant differences between the study sample's opinions about the impact of blockchain technology characteristics and the supply chain performance in Saudi industrial companies.

Lastly, we encourage the application of Blockchain technology in the supply chain sector in companies, by creating a reliable, real, transparent, and secure system due to the creation of added value to products, speed of response to customers' desires, and monitoring of costs attributed to suppliers. The researcher recommends conducting future research in the field of the relationship of Blockchain technology to corporate governance, studying the tax problems of Blockchain operations, and training accountants and workers in industrial companies to deal with Blockchain in a way that is appropriate to their job tasks for improving the supply chain performance and the competitive position of business organizations.

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