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**LFScholars: Effectiveness and Security Factors of Blockchain
Technology for Cryptocurrency and
Non-Fungible Tokens (NFTs)**

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**In Partial Fulfillment of the Requirements for the Course
Application Development and Emerging Technologies**

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HISTORY OF BLOCKCHAIN TECHNOLOGY

Blockchain technology has revolutionized transactions and data management, garnering significant attention and impact in recent years. Its roots can be traced back to the late 1980s and early 1990s with the introduction of consensus models and electronic ledgers.

The concept was expanded upon by Satoshi Nakamoto in 2009 and was then used to create the cryptocurrency Bitcoin. Shortly after the Global Financial Crisis that happened in the same year, Bitcoin's introduction and the idea to utilize cryptocurrencies or digital cash efficiently addressed the problem of double-spending, opening up opportunities for the widespread adoption of blockchain technology.

Blockchain technology continuously evolves and demonstrates immense potential, with its fundamental properties of security, immutability, and decentralization proving valuable in various industries, particularly in cryptocurrencies like Bitcoin and Ethereum. It acts as the foundational framework for modern cryptocurrencies and a transformative force in the finance, supply chain, and healthcare sectors.

The impact of blockchain technology has reached the shores of the Philippines, driving remarkable growth, economic advancement, and innovation within the country. In 2017, Bitcoin, the first decentralized cryptocurrency, became popular in the Philippines (England, 2021).

The rise of blockchain, coupled with the COVID-19 pandemic, has intensified interest in Bitcoin as an investment. Additionally, Filipino individuals have discovered new income opportunities through games like Axie Infinity, where they can earn money through digital wallets and NFTs.

Investment opportunities and guilds have thrived within Axie Infinity to meet the growing demand. These guilds offer scholarships to players who cannot afford in-game creatures (Axies) in exchange for a portion of their earnings. This trend showcases the employment and economic potential of blockchain-based NFTs and games.

Moreover, Bitcoin trading and cryptocurrency transactions in the Philippines have exceeded previous records, indicating significant demand for digital assets and reflecting the rising interest in cryptocurrency. The country's central bank, the Bangko Sentral ng Pilipinas (BSP), recognizes cryptocurrencies as legitimate payment methods, issuing guidelines for virtual currency exchanges and embracing blockchain technology. The BSP plans to launch a wholesale central bank digital currency (CBDC) project to enhance domestic and cross-border payments and contribute to economic recovery.

The adoption of blockchain technology and cryptocurrencies are expected to grow in the Philippines as individuals explore their potential applications within the country's financial infrastructure (Ta-asan, 2022).

WHAT IS BLOCKCHAIN?

The blockchain serves as the underlying technology for trading cryptocurrencies and NFTs. It operates as a distributed database spread across interconnected computers, allowing the recording of different types of information like *cryptocurrency transactions*, *NFT ownership*, and *DeFi smart contracts*. It is a decentralized *digital ledger*, securely recording and verifying transactions across multiple computers or nodes (Ta-asan, 2022). Described as a collection of interconnected records, blockchain is highly resistant to alteration and protected using *cryptography*. It functions as a chain composed of individual blocks of data. Each transaction is recorded as a block, ensuring the integrity of the information.

1. BLOCKCHAIN ARCHITECTURE

1.1 Decentralization

In traditional centralized systems, transactions are validated by a central authority, which can be costly and lead to performance issues. However, in blockchain, no central authority is required. Instead, a decentralized network of participants uses consensus algorithms to maintain data integrity and stability.

1.2 Persistency

Valid transactions are swiftly verified and cannot be deleted or reversed once included in the blockchain. Invalid transactions are rejected, preventing them from propagating further within the network.

1.3 Anonymity

Blockchain allows users to interact using generated addresses, preserving their privacy by not revealing their real identities. However, it is essential to note that blockchain does not provide absolute privacy due to the permanent nature of the recorded transactions.

1.4 Auditability

Blockchain stores user data using the *Unspent Transaction Output (UTXO) model*. Each transaction references previous unspent transactions, and once a transaction is recorded, the referenced outputs transition from unspent to spent. This enables easy tracking and prevents double-spending.

1.5 Transparency

Blockchain operates on a transparent system similar to cryptocurrencies like *Bitcoin*. Transactions are associated with addresses, ensuring transparency of the transaction history. While personal identities are hidden for security reasons, the owner of a block's address is responsible for the associated transactions.

1.6 Cryptography

Security is a fundamental aspect of blockchain, and it achieves this through *cryptography*. *Encryption* techniques, such as ciphers and cipher text, are employed to safeguard the data stored in blockchain blocks, ensuring the integrity and confidentiality of the information.

A *cryptographic hash function* is utilized to enhance the blockchain's security. This function is crucial in protecting the data stored within blockchain blocks. It converts the information into a fixed-length string of characters known as a *hash*, representing the input data. This distinct output is also called a message digest or simply digest.
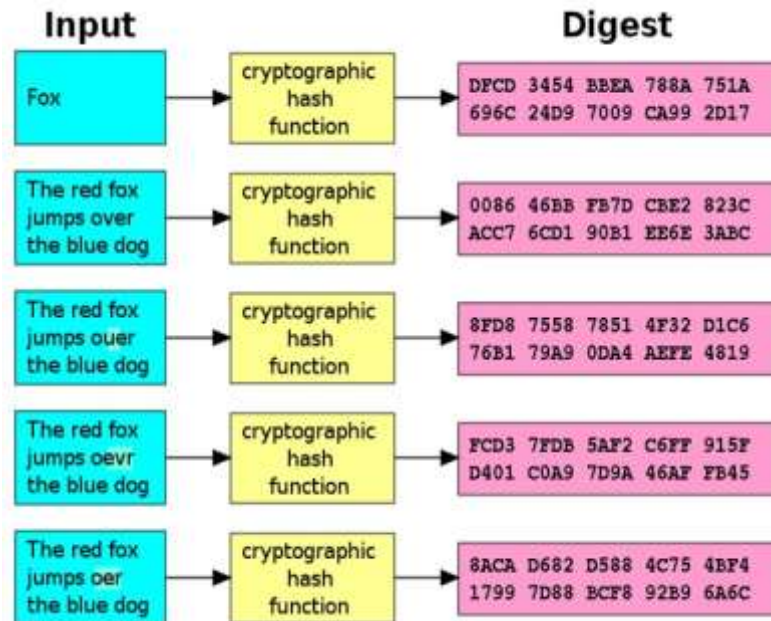

Figure 1: Illustrations of how cryptography works

2. CORE COMPONENTS OF BLOCKCHAIN ARCHITECTURE

2.1 Node

Nodes are participants in the blockchain network, and their devices enable them to maintain and communicate with the distributed ledger. Nodes serve as communication hubs and share information with other nodes in the network. When a *miner* adds a new block to the blockchain, it is broadcasted to all network nodes.
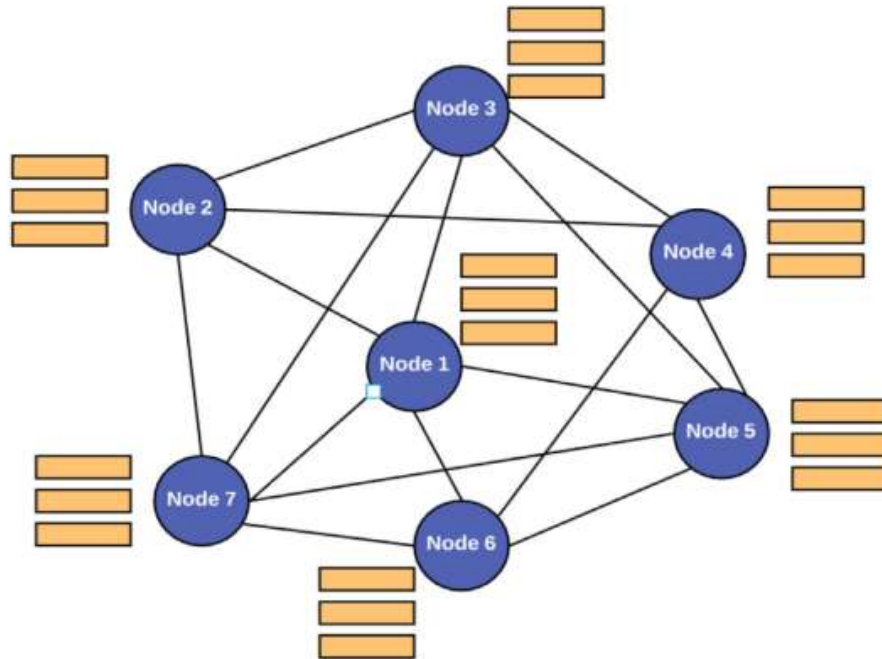
Figure 2: Node Connection, as demonstrated by Mohanta et al.

2.2 Transactions

Transactions represent agreements or contracts that involve the transfer of assets, such as cash or property, between parties. The blockchain network stores transactional data as copies in a digital ledger, ensuring transparency and immutability.

Ledgers: Ledgers in blockchain refer to the distributed and decentralized databases that store and maintain records of transactions. Ledgers provide transparency and immutability by ensuring all participants access the same information.

For instance, consider a group of friends gathering to eat at a restaurant. When it is time to pay the bill, one person volunteers to cover the entire amount. Afterward, the friends split the bill and used cryptocurrency to settle the expenses. In this scenario, the two friends who owe money send two tokens each to the person who paid the bill. In cryptocurrency transactions, the input consists of the cryptocurrencies owned by each participant, along with the specific amount they are sending to cover their share of the bill. The output of the transactions would be the updated cryptocurrency balances for each participant, reflecting the transfer of tokens from the friends who owed money to the person who paid the bill.
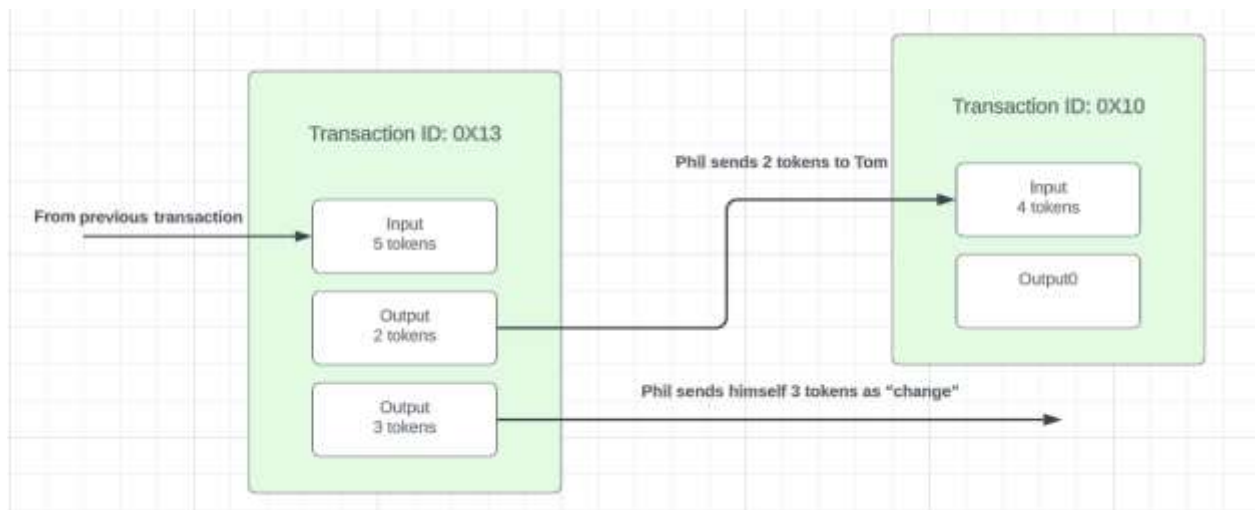
Figure 3: P2P transaction between the two participants

2.3 Block

Blocks are fundamental units in a blockchain network, functioning as links in a chain. In cryptocurrencies, blocks store transaction records, which are encrypted into a hash tree structure. With many daily transactions, the block structure allows users to track and organize these transactions efficiently.

A block in a blockchain consists of several components:

Header: The header is like an ID card for a block in the blockchain. It contains essential information about the block and is used to identify it uniquely. Miners periodically change a *nonce value* in the header and hash it to find a valid block.

Previous Block Address/Hash: This is like a chain that connects blocks. Each block contains a reference to the previous block's hash in the chain. It helps maintain the order and integrity of the blockchain.

Timestamp: The timestamp is like a timestamp on a document. It indicates the exact time and date when a block is created. It helps ensure the chronological order of events in the blockchain.

Nonce: A nonce is a unique number that is used only once. It plays a role in the proof-of-work process of mining a block. When combined with other block data, miners test different nonce values to find one that produces a hash value that meets specific criteria.

Merkle Root: The Merkle root summarizes all the transactions in a block. It is calculated by creating a digital fingerprint (block hash) of each transaction and combining them in a specific way. The Merkle root allows users to verify the integrity of transactions and determine if they belong to a particular block.

The block inherits the previous hash, and the blockchain system uses this previous hash to create new blocks. This makes the blockchain tamper-proof. Mining statistics is the various

metrics and data. Mining statistics in blockchain provide data on the mining process. Miners create and validate blocks using complex algorithms, making them tamper-proof. The statistics include hash rate, difficulty, rewards, block time, and mining power distribution.
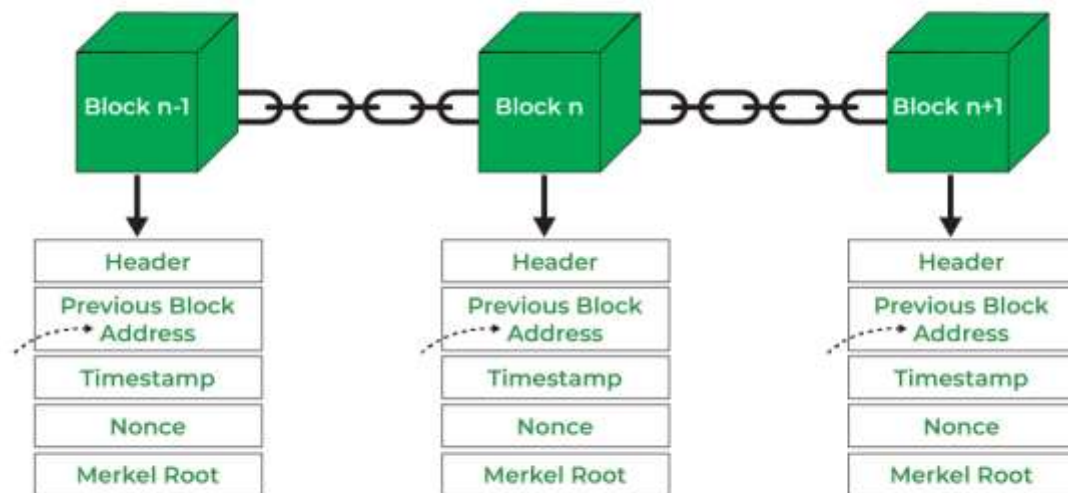

Figure 4: Attributes of a Blockchain from GeeksforGeeks

The Merkle Root generates the different block Hash within a blockchain. Modifying a transaction would require altering all subsequent block hashes. The level of difficulty in the mining algorithm determines the degree of tamper resistance in a blockchain block. A higher difficulty makes it more challenging to manipulate the block's contents, thereby enhancing the security of the blockchain.
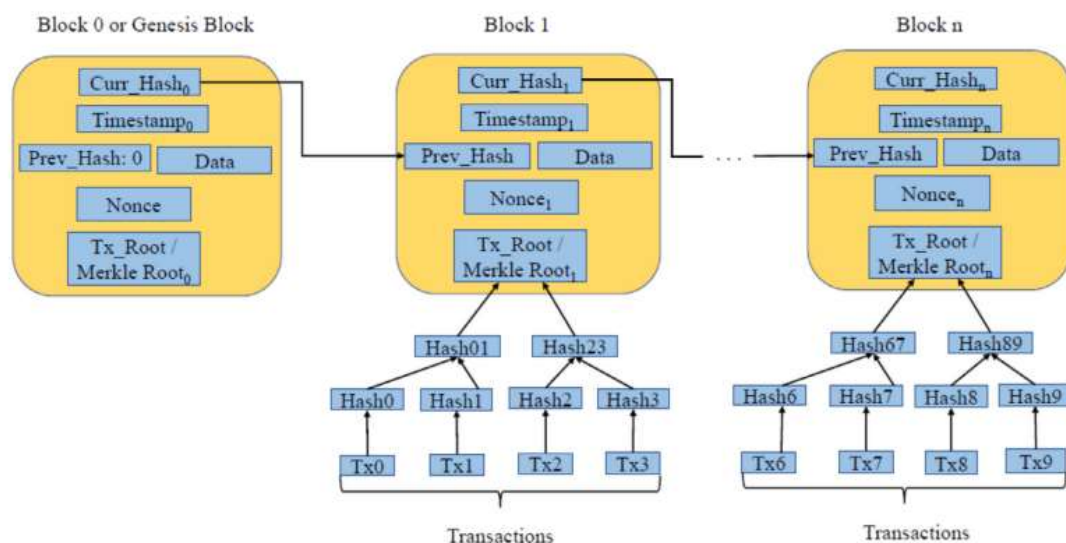

Figure 5: The Merkle Root, as demonstrated by Mohanta et al.

2.4 Chain

The chain refers to the corresponding sequence of blocks in the blockchain network. Blocks are linked using the previous block's hash, creating a chain-like structure. This chaining mechanism ensures the integrity and chronological order of transactions in the blockchain.

2.5 Miners

Miners are individuals or entities involved in the process of blockchain mining. Mining involves validating transactions and adding them to the blockchain. Transactions typically need to be approved by miners before they are considered valid and added to the blockchain. The process of approving transactions is often referred to as transaction validation or consensus. Miners perform complex computational tasks to verify transactions and maintain the security and integrity of the blockchain network.

2.6 Consensus

Consensus mechanisms are fault-tolerant mechanisms used in computer and blockchain systems to achieve agreement on the network's state. In cryptocurrencies, consensus ensures agreement on transaction validity and the order of transactions across the distributed network. Miners or validators compete to solve complex mathematical puzzles or stake their coins to secure the network. This process ensures that only valid transactions are added to the blockchain.

3. TYPES OF BLOCKCHAIN

3.1 Public Blockchain

A public blockchain is an open network in which anyone can participate. It is decentralized and transparent, allowing anyone to read, write, and audit the blockchain's activities. It cannot be modified once data is validated on the public blockchain. It is accessible to everyone, and no permission is required to join or access the network.

3.2 Private Blockchain

A private blockchain requires permission to access. It operates based on controlled participation, limiting access to specific entities. Only authorized participants know transactions, and outsiders cannot access the blockchain. A single entity manages private blockchains, and the entity controls access rights. There may be restrictions on accessing the network of a private blockchain.

3.3 Consortium Blockchain

A consortium blockchain is a permission by a group of organizations or government entities rather than a single entity. It offers a balance between public and private

blockchains. Consortium blockchains are more decentralized than private blockchains, enhancing privacy and security. Access to consortium blockchains is limited to the collaborating organizations within the consortium, and external access is not granted. Organizations within the consortium work together collaboratively.

4.   CONSENSUS ALGORITHM

A consensus algorithm is a mechanism or protocol used in distributed systems to achieve agreement or consensus among multiple participants or nodes. In a distributed system, where multiple nodes need to work together and make collective decisions, consensus algorithms ensure that all nodes agree on a single, consistent state of the system.

4.1 Proof of Work (PoW)

Participants (stakeholder nodes) must prove that they have performed a certain amount of computational work to validate transactions and add them to the blockchain. Miners need to invest computational power by performing numerous calculations until they find a solution (nonce) that satisfies the difficulty requirement. The miner who finds the solution first gets to propose the next block and is rewarded with newly minted cryptocurrency or transaction fees. The security of the blockchain is based on the majority of miners being honest and the overall computational power of the network.

4.2 Proof of Stake (PoS)

Participants are chosen to validate transactions and create new blocks based on their existing "stake" or coins they hold, reducing the need for extensive computational work (mining). The security of PoS blockchains depends on the economic incentives of validators, as they risk losing their stacked coins if they act maliciously.

4.3 Proof of Capacity (PoC)

Proof of Capacity involves sharing the available memory space of nodes in the blockchain network. Participants allocate storage space in advance to demonstrate their eligibility to validate transactions and create blocks. This approach reduces energy consumption compared to PoW.

4.4 Proof of Elapsed Time (PoET)

A consensus algorithm that uses cryptography to determine the time duration for each participant to take turns in validating transactions and adding them to the blockchain. It aims to achieve agreement and fairness among participants without requiring extensive computational resources.

4.5 Delegated Proof of Stake (DPoS)

A consensus algorithm is used in blockchain networks where delegates are selected through a voting process to validate data blocks. These delegates, also known as block producers or witnesses, maintain the blockchain's integrity.

4.6 Practical Byzantine Fault Tolerance (PBFT)

A consensus algorithm ensures that computers in a network reach agreements, even in the presence of faulty or malicious computers. It allows the network to function correctly despite computers not working properly or attempting deception. PBFT employs a voting system where computers vote on decisions, and the majority's decision is accepted. This algorithm ensures reliable network operation and problem-handling capabilities.

HOW BLOCKCHAIN WORKS?

In Blockchain technology, when a transaction occurs, the record is created in the form of blocks, which permanently contain all the transaction details. These blocks form a chain of records called a ledger, shared among the participants, acting as a publicly distributed ledger. The information in each block is encrypted using an encryption algorithm, resulting in a unique hash. This hash is included in the following block, forming a chained block series.
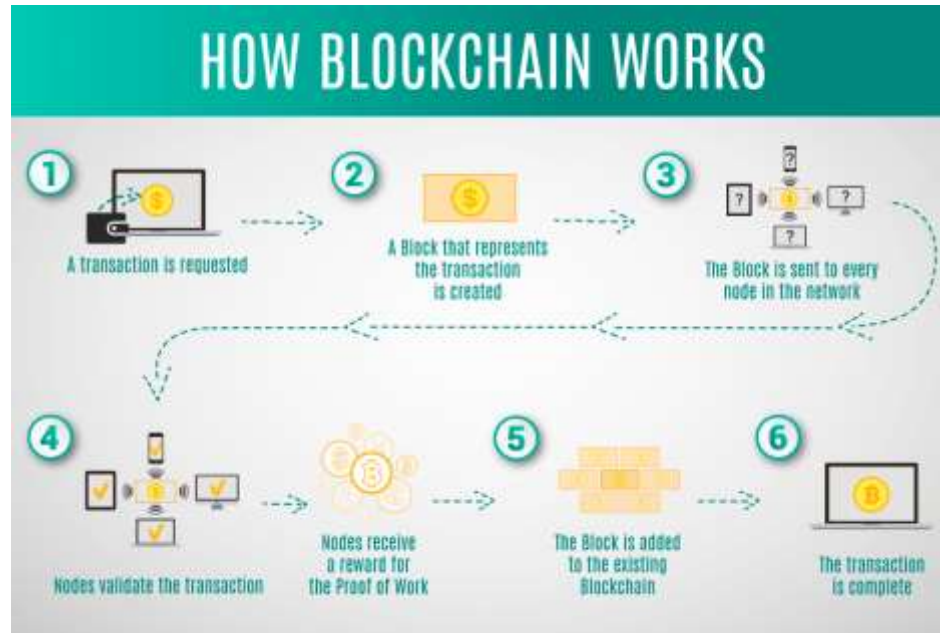

Figure 6: Blockchain Flow

To better understand blockchain technology, envision a shared spreadsheet representing the blockchain itself. Participants can contribute transactions to the spreadsheet, which serves as recorded data within the blockchain. Each transaction undergoes transformation through cryptographic hash functions, ensuring integrity and authenticity.

Before adding a transaction, a participant supplies a nonce for security and attaches a digital signature using their private key to validate their identity. Other participants use public keys to verify the signature, and unique addresses derived from public keys identify senders and receivers in recorded transactions.

Private keys must be carefully safeguarded, similar to personal passwords or encryption keys, as losing them results in losing access to associated addresses and transactions.

The shared spreadsheet operates as a ledger, meticulously documenting all recorded transactions and serving as a distributed and synchronized database accessible to all participants.

Multiple transactions are consolidated into blocks to organize transactions, and each block references the preceding one, creating a chain-like structure. This chaining mechanism ensures the integrity and immutability of recorded transactions within the shared spreadsheet.

Objectives

Blockchain technology is a revolutionary concept that has grown in popularity in recent years. It is a decentralized and distributed digital ledger that records transactions in a safe and transparent manner. Our research goals include the following:

- To discuss the History of blockchain technology, how it works, its uses and its function.
- Determine its importance in different areas of Blockchain technology especially on Crypto and NFT.
- Observe the blockchain technology by discussing its current state in the Philippines, popular cryptocurrency, rules and regulations, trends and emerging technologies.
- Analyze blockchain technology using various statistics and research.
- Evaluate blockchain technology through case reports, its effects and benefits.

Scope and Delimitation of the Study

The scope of this research is to look into the applications and functionality of blockchain technology in the context of cryptocurrency and non-fungible tokens (NFTs). The study, which focuses on the Philippines, seeks to evaluate the use and influence of blockchain technology on cryptocurrencies, including issues such as creation, transactions, and storage. Furthermore, the research will look into the use of blockchain technology in the production, and ownership verification of NFTs, specifically in the Philippine market. The study intends to provide a full grasp of the practical implications and possible benefits of blockchain technology in the realms of Bitcoin and NFTs in the Philippines by delving into these areas.

The focus remains on cryptocurrency and NFTs within the Philippines. Therefore, it will not extensively analyze or compare the global blockchain landscape or international regulatory frameworks. While the study acknowledges the technical aspects of blockchain technology, it will not provide an in-depth analysis of the underlying technical protocols or algorithms employed by blockchain networks. Moreover, It is important to note that this study does not provide financial advice or investment recommendations. Instead, it should be regarded as a reference source for understanding blockchain technology and its application in the cryptocurrency and NFT domains. The study aims to present an objective

analysis of the effectiveness and security factors of blockchain, offering insights into its potential advantages and limitations.

Presentation of the Chosen Study

Uses and Functions

Due to blockchain's capabilities and potential, it can be applied in various areas, including financial services and administering voting systems. The following are some of the areas where blockchain is used:

1. **Cryptocurrency**

The Global Financial Crisis 2008 significantly impacted trust in traditional financial systems and institutions. In response, Bitcoin emerged as a prominent cryptocurrency, offering an alternative independent of central banks and traditional financial institutions. This event ignited curiosity and interest in cryptocurrencies, leading more people to explore digital currencies like Bitcoin and Ethereum. As the usage of cryptocurrencies increases, it paves the way for the wider adoption of blockchain technology (Rodeck & Curry, 2022).

Cryptocurrencies are digital currencies that facilitate peer-to-peer transactions, including buying, exchanging, and spending. At the heart of cryptocurrency is blockchain, a decentralized and distributed ledger that records transactions across multiple computers or nodes. Each transaction is grouped into a block and added to a chain of previous blocks, creating a chronological history of all transactions. The decentralized nature of blockchain ensures that no single entity or central authority has complete control over the system, making it resistant to manipulation and censorship.

Cryptography, which involves secure communication in the presence of third parties, plays a crucial role in blockchain technology. The term "crypto" in cryptocurrency highlights the significance of cryptography in securing transactions and protecting user information from malicious activities.

The growing acceptance and utilization of cryptocurrencies and participation in blockchain networks by individuals contribute to the expansion of blockchain technology. As the user base continues to grow, it strengthens the foundation for broader adoption and integration of blockchain across various sectors and industries.

2.   Banking

Blockchain technology offers significant advantages in the world of financial transactions. With its decentralized and transparent nature, transferring fiat money, such as dollars and euros, through a bank or financial institution becomes faster and more efficient. Transactions can be quickly verified and processed, even outside normal business hours.

One key advantage of blockchain is its elimination of third parties (bank companies), enabling direct and peer-to-peer transfers. This reduces costs and enhances the speed and efficiency of transactions.

Additionally, blockchain provides an additional layer of security. Transactions are recorded on a distributed ledger, where each transaction is encrypted and linked to the previous one, forming an immutable information chain. This ensures transparency and safeguards against fraudulent activities.

3.   Asset Transfers

The concept of ownership has expanded to encompass digital assets in the online world. Digital ownership refers to the rights and control one has over digital assets. As the internet and digital economy have grown, the importance of digital ownership has become more prominent. Blockchain technology enables secure and decentralized digital ownership, revolutionizing how we manage our digital assets.

Blockchain, smart contracts, and digital signatures ensure a secure and transparent record of ownership and asset transfers. The blockchain serves as a decentralized ledger for recording ownership, while smart contracts enforce agreements between parties. Digital signatures provide proof of asset ownership.

Fractional ownership becomes possible through blockchain, as assets can be divided into digital tokens. This introduces benefits such as transparency, security, liquidity, and accessibility, simplifying the process of buying and selling.

Blockchain technology tracks and facilitates the transfer of ownership for non-fungible tokens (NFTs), which represent ownership of digital artwork and videos. NFTs are assets tokenized through a blockchain (Sharma, 2023).

NFTs create unique digital certificates recorded on a decentralized digital ledger or blockchain. Each NFT has a distinct digital signature that establishes ownership. NFTs can be traded and exchanged for money, cryptocurrencies, or other NFTs, depending on their value, market conditions, and the preferences of the owners. The immutability of the blockchain ensures a secure and transparent record, enabling seamless transfers of NFTs between owners.

Various NFT platforms and marketplaces have emerged, offering a space for artists and creators to showcase and sell their digital assets. Platforms including OpenSea, LooksRare, and X2Y2.io provide a marketplace where NFTs can be bought, sold, and traded. These platforms use blockchain technology to ensure transaction transparency, security, and the uniqueness and ownership of the NFTs.

Fungible Tokens vs Non-Fungible Tokens

Fiat currencies and cryptocurrencies like Bitcoin and Ethereum are interchangeable and have equal value. Fungible tokens are identical and can be divided into smaller units without losing value. For example, exchanging one bitcoin will always have the same value as any other. The same principle applies to Philippine currency, exchanging a 100 peso bill for another 100 peso bill will have the same value since both bills are identical. Each 100 peso bill is worth the same amount and is interchangeable. The value of each individual 100 peso bill is the same, so it doesn't matter which one you have.

On the other hand, non-fungible tokens (NFTs) are unique and indivisible. They represent ownership of a specific item. Each NFT contains a distinct item or piece of content stored on the blockchain, providing proof of ownership and authenticity. In the actual world, the intellectual property rights for artistic and creative works relate to owning digital assets. Each original artwork is unique and possesses its own intrinsic value. Just as an artist can create a one-of-a-kind masterpiece that cannot be replicated, a non-fungible token represents the ownership and authenticity of that artwork. In a similar way, NFTs can show ownership and authenticity for digital assets like music, artwork, or other kinds of intellectual property, guaranteeing its individuality and value.

4.   Smart Contracts

Smart contracts are computer programs that automate and facilitate the transfer of digital assets based on predefined conditions. They function as digital contracts, using code instead of legal enforcement. Initially used in the Bitcoin network, smart contracts gained greater capabilities with platforms like *Ethereum*, enabling the creation of customized contracts using a language called *Turing-complete*.

Blockchain technology is crucial for the operation of smart contracts. It provides a secure and decentralized system where contracts are stored and supervised by a network of computers. Smart contracts possess key features such as distribution to all network nodes, deterministic execution, and immutability once deployed. They operate without intermediaries, allowing customization and ensuring transparency for participants. These contracts offer advantages such as accuracy, automation, speed, backup, security, cost savings, and information management.

To operate, a smart contract relies on the secure coding of the blockchain. It contains predefined rules and conditions that trigger agreement when specific events occur. Each contract possesses a unique address on the blockchain for interactions.

5.   Supply Chain Monitoring

Supply chains handle vast amounts of information as goods move through various places. However, traditional storage methods can be inefficient and make identifying the source of problems easier. Utilizing blockchain, a decentralized storage solution makes tracking and monitoring the supply chain easier.

Blockchain technology can transform the supply chain by enhancing efficiency and transparency. Companies like Maersk and IBM already utilize blockchain to streamline processes and improve visibility. Acting as a distributed ledger, blockchain securely records transactions, enabling the traceability of products from their origin to sale. This reduces delays, costs, and errors.

Moreover, by eliminating the need for intermediaries, blockchain reduces the risk of fraud and enables comprehensive record-keeping. Shared blockchain ledgers allow companies to synchronize logistics data, track shipments, and automate payments while ensuring data privacy. Direct transactions and integration with RFID tags further enhance efficiency, while the immutability of blockchain records fosters transparency, accountability, and the mitigation of illegal activity.

6.   Healthcare

Blockchain is a decentralized and transparent digital ledger that records transactions. Blockchain has reached the healthcare industry with a rising acceptance rate (Haleem et al., 2021).

In healthcare, it serves various purposes and offers multiple benefits. It helps facilitate the preservation of product integrity, the prevention of counterfeit pharmaceuticals, and the confidentiality of patient records. Blockchain increases data security, enables accurate treatment and research, and promotes health information transmission. It also improves supply chain management, enhances transparency in the prescription process, and gives patients control over their medical data. By adopting Blockchain technology, healthcare could optimize efficiency, accuracy, and confidence in service delivery. It also helps to reduce financial failures and prevent theft and illegal record transfers.

7.   Voting

Blockchain technology can enhance the voting system's openness, safety, and reliability. A blockchain-based voting system records each vote as a transaction on distributed ledgers. This decentralized approach protects voters' identities while allowing anyone to verify the vote count (Jafar et al., 2021).

Blockchain technology offers several benefits to the voting process, including transparency, security, trust, fraud prevention, and accessibility. Transparency is achieved by making all transactions visible, enabling easier detection of fraudulent activities. The cryptographic techniques employed in blockchain make altering votes nearly impossible, ensuring their security. These techniques involve complex mathematical algorithms that protect the integrity of each vote.

In addition, the absence of a central authority in blockchain fosters trust among participants, who can independently verify their votes. Blockchain's consensus

mechanisms, such as Proof of Work or Proof of Stake, make it challenging to manipulate votes, thus preventing fraud.

Furthermore, blockchain enables secure remote voting, increasing accessibility for individuals unable to visit polling stations.

Importance

Blockchain technology is straightforward yet constantly evolving, expanding the network of blocks to meet the specific needs and characteristics of various industries (Haleem et al., 2021).

As a distributed ledger, blockchain ensures transparency, security, and immutability across sectors. In the digital currency world, it offers trust, transparency, and resistance to manipulation, providing an alternative financial system. Eliminating intermediaries enables faster and more efficient transactions while maintaining an immutable record in banking. Blockchain also revolutionizes digital asset ownership through decentralized record-keeping, fractional ownership, and seamless transfers of assets like NFTs.

Moreover, blockchain ensures secure and transparent smart contract operation, offering benefits such as accuracy, automation, speed, security, and cost savings. It enhances supply chain efficiency, transparency, and traceability by securely recording transactions, reducing fraud risks, and streamlining processes. In the healthcare industry, blockchain improves data security and product integrity and prevents counterfeit pharmaceuticals, enabling accurate treatment and research. Additionally, it enhances supply chain management, prescription transparency, and patient control over medical data. Utilizing blockchain-based voting systems fosters openness, security, trust, fraud prevention, and accessibility through transparent and tamper-resistant vote records, enabling secure remote voting.

I.Technology observations

The development of blockchain technology continues to be in its early stage of improvement. Don Tapscott and Alex Tapscott write a book entitled Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World contend that cryptocurrencies not just make international money transfers less difficult and more affordable but also make a way on how many people could benefit from it rather than few , and that blockchain may offer a more reliable way for us to store and exchange our cash and can change how our institutional sectors works. In that way, blockchain technologies are being used to transform the way we handle data in industries like financial institutions, healthcare and government sectors.

Current state of Blockchain in the Philippines

In the Philippines, the blockchain technology was initially introduced in 2009, and through time, it gained popularity there. According to the data collected by the World Bank in 2021, the Philippines is the 36th-largest economy by nominal GDP and the third-largest economy in Asia. Despite its small size, the country is considered to be one of the fastest-growing economies in the international market due to its transition from agricultural country to services and industrialization. Also, as reflected in Chainalysis's Global Crypto Adoption Index 2022, where it now ranks second, only behind its ASEAN neighbour, Vietnam.

Over the past years, cryptocurrency became extremely popular in the Philippines due to its economic shift in digital assets. In fact, according to an article of Bitcoin (2018), The Philippines government-owned **Cagayan Economic Zone Authority (CEZA)** has partnered with Northern Star Gaming & Resorts Inc. to develop a crypto and fintech hub called **Crypto Valley of Asia (CVA**). Cryptocurrency is digital money, making it virtual and having no physical form. "**Crypto**" refers to the various encryption algorithms and cryptographic techniques that safeguard these entries, such as elliptical curve encryption, public-private key pairs, and hashing functions. It is purely digital, meaning it can be stored online and even in small, specially designed hardware.

According to the Finder Cryptocurrency Adoption Index report in 2022, Bitcoin (BTC) is the most popular cryptocurrency with over 36% crypto owners in the Philippines followed by Ethereum (ETH) and Dogecoin (DOGE). Additionally, as reported by the same adoption index, the Philippines ranks 12th out of 26 countries for crypto adoption with over 11.6 million Filipinos owning digital assets.

Popular Cryptocurrency	Symbol	What is it?	How does it work?

Bitcoin		The first cryptocurrency ever created was Bitcoin. Satoshi Nakamoto created it on October 31 and officially released it on January 3 of 2009. Three concepts can all be referred to as "Bitcoin": • The digital currency, Bitcoin (BTC) • The Bitcoin blockchain • The Bitcoin network	Bitcoin is a decentralized digital money that is independent and does not use financial institutions and centralized authorities like government sectors. It uses peer-to-peer transfers and a virtual network that records all cryptocurrency trades. It is powered up by the blockchain, an open source code that couples up or links blocks of transaction histories to prevent tampering.
Ethereum		Vitalik Buterin introduced the world to Ethereum in a 2014 whitepaper. A year later, he and Joe Lubin launched the Ethereum blockchain, the decentralized, global software platform and open-source blockchain best known for its smart contract functionality, which eventually led to its popularity for NFTs. Ethereum's native currency is **Ether**, which is commonly	Ethereum is a Layer 1 (often abbreviated as "L1") blockchain, which means it executes and validates transactions independently without assistance. Ethereum facilitates everything from the buying, selling, and storing of NFTs to Decentralized Finance (also called "DeFi").

		abbreviated to ETH. Ethereum is the blockchain itself, while Ether (ETH) is the currency used to make transactions on the Ethereum blockchain.	
Dogecoin		In 2013, Jackson Palmer and Billy Markus founded the open-source cryptocurrency known as Dogecoin. It is an open-source, peer-to-peer cryptocurrency Dogecoin (DOGE). It is regarded as an alternative cryptocurrency and debuted in December 2013 with a Shiba Inu dog as its logo.	Dogecoin operates using blockchain technology. The goal of Dogecoin was to build a strong user base for an entertaining and simple use of Litecoin alternative, which is also an alternative to Bitcoin. It uses a proof-of-work consensus mechanism by the Dogecoin blockchain, in which miners use computers to execute transactions and log them on the blockchain by solving challenging mathematical problems.

One good thing about cryptocurrency is that you can easily send your digital money to anyone, anytime, anywhere. As it works through blockchain technology.

How do people earn in Cryptocurrency and NFTs

According to the article of Moneymax (2022) "Bitcoin Guide: How to Buy Bitcoins in the Philippines", Filipinos earn Bitcoins through the following:

1. **Buy Bitcoin on an Exchange**

- You may purchase, sell, or trade cryptocurrencies on exchange websites. You may immediately purchase Bitcoin using Philippine pesos on a number of exchanges, including Coins.ph, PDAX, Binance, and BloomX.
- It is designed for those new to cryptocurrency investing who just want to purchase Bitcoin for use in trading or investing. They may keep their money in the digital wallets and just wait for their value to rise.

2. **Earn Bitcoin by Mining**
- Bitcoin mining is an integral part of how bitcoin works. Mining is the process by which special bitcoin users (called miners) compete with each other to discover new bitcoins and add recent bitcoin transactions to bitcoin's public ledger. In order to spend or receive bitcoins, a bitcoin user must create a transaction and broadcast it to the entire network, validate it and then, for this transaction to successfully go through, it must be permanently recorded on the block chain. A transaction block – a condensed record of all the transactions for that period of time.
- Miners used mining software like CGMiner, BFGMiner, MultiMiner, and Awesome Miner in order to get bitcoins. A proof-of-work scheme is considerably using difficult mathematical problems that a miner must solve. In order to have a particular number of bitcoins and be rewarded for solving it, this proof-of-work system was intended to have solutions that are simple to verify but extremely difficult. The network adjusts its difficulty based on how quickly miners solve those math problems when each transaction has to be accepted or validated. *ASIC (Application-Specific Integrated Circuit Chips)* are made particularly for bitcoin mining to mine faster. But over time, as more people adopted bitcoin mining, it became more difficult for individuals to solve math problems. As a result, they invented pooled mining, which combines the effort of miners to achieve a single objective. However, groups of miners work through mathematical problems more quickly than individuals and are equally rewarded.

3. **Receive Bitcoin as Payment**
- But if you're still wondering where you can use your bitcoins, here's some online and offline merchants that accept the cryptocurrency as payment in the Philippines:
    1. Metrodeal & CashCashPinoy- the country's top two daily deal sites – started accepting bitcoin payments. This is one more payment option for customers, who are now not just limited to credit card and ATM payments.
    2. Wirin Cupcakery - is an online seller creating made-to-order cupcakes. It offers delivery within Metro Manila and customers can easily pay in bitcoin upon delivery.

According to the article of Bitpinas (2021) "Axie Infinity: Earn Money Playing Axie Infinity", Filipinos earn Ethereum (ETH) through the following:

1. **Earn by Playing Axie Infinity**
- Axie Infinity, a Pokemon-inspired play-to-earn metaverse game created on the Ethereum blockchain and one of the popular block-chain based games and the game-changer or play-to-earn system was created by Vietnamese video game developer Sky Mavis in 2018. The game contains creatures called "Axies" that players collect and use to duel other players and enemies. Every Axie is a Non-Fungible Token (NFT) , minted on the Ethereum blockchain that is adapted from the blockchain technology of

Bitcoin and other Cryptocurrencies. As an evident on how cryptocurrencies become popular in the Philippines is the fact that based on the data from ActivePlayer.io, 40% of all the players of the popular play-to-earn (P2E) game Axie Infinity were from the Philippines. In fact, the game has also been a financial game-changer for many citizens in the country.

2. **Buy ETH**
   - Buying and selling cryptocurrency in Coins.ph

According to Smart Trading (n.d.), an example of online broker in the Philippines, Filipinos earn Dogecoin through the following:

1. **Buy and Sell**
   - To buy Dogecoin in the Philippines, you should first choose an online broker like Smart Trading. The online broker will provide a trading platform for transactions. Then you need to go through a simple registration process on the platform, open and fund your account.
2. **Lending**
   - You can lend Dogecoin in exchanges like Smart Trading

Rules and Policy on Crypto and NFT

In terms of mandated law, the government of the Philippines is still in the process of putting or establishing legal and comprehensive frameworks for the use of the blockchain technology and digital assets. However, The Bangko Sentral of the Philippines (BSP) has issued a *Circular No. 944 dated 06 February 2017* that defines *that:*

- *Virtual Currency Exchanges are companies or businesses engaged in changing VCs into fiat currency (and vice versa).*
- *The act of converting VCs into Philippine money can facilitate payments and remittances.*
- *Circular 944 requires VC Exchanges to register with the BSP as remittance and transfer companies. They are also required to put in place adequate safeguards to address the risks associated with VCs. These include control measures to counter money laundering/ terrorist financing (ML/TF), technology risk management systems, and consumer protection mechanisms.*

Making blockchain and digital assets legal in the Philippines. Also, the Digital Asset Token Offering (DATO) is a regulatory framework for the issuance of digital token in the Philippines that was created by Cagayan Economic Zone Authority (CEZA). DATO regulations govern acquiring and launching crypto assets, whether they are security or utility tokens. Token offerings are required to have proper offering documents and extensive disclosure of details surrounding the project, including certification from experts. The tokens will then be listed on the licensed "Offshore Virtual Currency Exchange" (OVCE).

In addition to this, BSP referred to cryptocurrencies as digital or virtual assets. Cryptocurrencies can be taxed as either ordinary or capital assets depending on their status as assets. Despite the lack of clear guidelines from the Bureau of Internal Revenue (BIR), investors should expect their income from dealing with cryptocurrency to be subject to taxation. In Philippine Interpretation Committee (PIC) Q&A 2019-02, the accounting treatment for cryptocurrency can follow the rules governing inventory or intangible assets.

- In Philippine Accounting Standard (PAS) 2, if cryptocurrency is treated as inventory, it may be considered ordinary assets subject to ordinary income tax, 12% VAT on the total amount of income.

- If your cryptocurrency appears as an intangible asset, you'll be taxed. It means that if you sell an intangible asset, you'll be taxed; the longer you hold the VCs longer then sell it, the lower your tax might be. If you hold your VCs for much less than a 12 months and eventually sell them, you'll have to pay a higher tax, that is equivalent to ordinary tax.

Trends and Emerging Technologies

A pilot program for a Central Bank Digital Currency (CBDC) will be started by the Bangko Sentral ng Pilipinas (BSP). The Project CBDCPh program intends to provide practical understanding of the fundamental facets of CBDC's nature and its implications for the nation's financial system.

The central bank of a country issues digital money known as CBDCs, which are regarded as obligations by that organization. There are two types of it, wholesale CBDCs and retail CBDCs.

1. **Wholesale CBDCs** are only utilized by financial institutions in their dealings with central banks and other financial organizations. Contrary to central bank money, which may only be used during the central bank's operating hours, wholesale CBDCs are accessible 24/7.
2. **Retail CBDCs** are utilized by individuals, organizations, and small enterprises for regular transactions and cater to retail transactions.

The BSP's Project CBDCPh is an exploratory project that aims to give a thorough overview of the possible effects of CBDCs on the Philippine financial system. In order to overcome frictions in the present national payment system, notably in the areas of safety, efficiency, and reliability, Project CBDCPh aims to identify important CBDC characteristics such as:

1. **Anonymity -** A token-based CBDC can be designed to provide anonymity, although the extent can be managed given the concerns regarding money laundering and terrorism financing.
2. **Transfer mechanism-** CBDCs can be transferred through a peer-to-peer basis or through an intermediary, such as a central bank, third-party agent, or commercial bank.
3. **Limits or caps -** A limit or cap can be implemented on the holdings of CBDCs to mitigate its potential adverse impact on certain sectors of the economy.
4. **Availability -** CBDCs could be made available 24 hours a day, seven days per week and not limited to the opening hours of a central bank.

According to BSP Governor Benjamin E. Diokno (2021), the pilot is a major step for both the BSP and the Philippine financial industry towards understanding the potentials and risks of a wholesale CBDC. Given that the vast majority of people still rely substantially on cash, the BSP has declared that it is uncertain that it will create its own Central Bank Digital Currency in the near future. BSP will keep an eye on local and international CBDC developments.

Built on the IBM Blockchain Platform, this supply chain finance solution from UnionBank will be available to all their customers and partners who will join the blockchain network. Aside from this, according to IBM (2018), The UnionBank, one of the largest banking organizations in the country, is working together with IBM on a blockchain-based solution that has the potential to reinvent supply chain finance by enhancing security, transparency and operational processes. Once a part of the network, all parties involved in a transaction can act on the same shared ledger, with each party updating only their

part of the process — ensuring efficiency, consistency, trust and transparency, while safeguarding sensitive information.

In conclusion, examining the growing popularity of blockchain technology in Philippine markets and across the globe reveals its huge potential for revolutionizing a wide range of industries, where it can result in improved overall efficiencies and lower costs due to strengthened digital safety protocols along with enhanced operations that facilitate transparency. The Philippines have already made advancement in integrating these technologies into several fields.

II. Technology Literature Reviews

In today's fast changing technology scene, staying up to date on the newest breakthroughs and their repercussions is critical. Through performing a series of Technology Literature Reviews (TLRs), this study attempts to provide a thorough overview of the current status of technology. This study tries to investigate the achievements, trends, and impacts of technology across numerous areas by diving into diverse sources of literature, including scholarly papers, industry reports, and expert analyses. The research attempts to find essential insights, emerging topics, and research gaps by an in-depth examination of relevant literature, ultimately contributing to the body of knowledge in the field of technology.

1. Studies and Statistics about Cryptocurrency

1.1. STUDY

According to the article of Yi Su, cryptocurrency, powered by blockchain technology, offers several advantages in the financial sector. Its finite supply ensures rarity, while decentralized control by programmers and math increases trust. The use of blockchain allows users to own their personal data, reducing security costs. Cryptocurrency protocols provide rules for applications within their environments, with consensus mechanisms ensuring the integrity of transactions. Asymmetric encryption safeguards the blockchain and provides secure account control. However, it is important to recognize that cryptocurrency technology is not immune to security risks and privacy concerns. Overall, cryptocurrency has the potential to revolutionize the financial landscape with its secure, decentralized, and efficient features.

1.2. STATISTICS

I.How many people use cryptocurrency?

In recent years, cryptocurrency has grown in popularity. By 2021, there will be over 300 million bitcoin users worldwide. This equates to approximately 3.9% of the population owning some sort of cryptocurrency. Furthermore, thousands of establishments accept cryptocurrency payments. These figures are projected to rise as more businesses see the significance of the industry.

II.   Bitcoin holds about 66% of the total market share in the economy.

Bitcoin accounts for around 66% of the overall value of the cryptocurrency market. Other cryptocurrencies have attempted to compete, but none have succeeded. Bitcoin had a market share of 100% when it initially started, and it had roughly 86% in 2015. This shows that other currencies are gradually displacing it.

2. Studies and Statistics about NFT

2.1. STATISTICS

Studies and statistics on NFTs provide insights into their popularity and impact. Researchers analyze market trends, user behavior, and the influence of NFTs on industries like art and gaming. These studies examine market size, transactions, artist earnings, buyer demographics, and implications for digital ownership. Stakeholders can gain a better understanding of NFT opportunities and challenges through these research findings.

Let us have a look at the NFT statistics and interesting facts in a detailed manner below.

I.The Largest NFT Marketplace is OpenSea

OpenSea is the largest P2P marketplace for Non Fungible Tokens, with a total trading volume of roughly $14.68 billion. OpenSea takes 90% of all the NFT trading volume.

OPenSea recorded an all-time high trading volume of $3.7 billion in January 2022. The brand has also aided in the creation of a number of other competitors, like Axie Infinity, which is currently valued at $3.94 billion. The CryptoPunks ($2.40 bil.) and the NBA Top Shot ($0.78 bil.) are two more well-known markets.

Below is the overview of Top Marketplaces for NFTs

Market	Average price	Traders	Volume, billions
OpenSea	$938.99	1,387,357	$14.68
Axie Infinity	$216.15	1,624,169	$3.94
CryptoPunks	$123,690.00	5,600	$2.40
NBA Top Shot	$63.63	492,039	$0.78
Magic Eden	$308.74	304,403	$0.62
Solanart	$1,100.00	170,703	$0.59
Mobox	$790.81	59,178	$0.53
AtomicMarket	$24.98	895,199	$0.32
Rarible	$990.79	92,115	$0.28
SuperRare.co	$7,940.00	5,493	$0.21

II. **Thailand is the country with the most NFT users.**

Thailand is home to 5.65 million NFT users in the world. Brazil and the United States stand in the second and third spot with 4.99 million and 3.81 million users, respectively.

Below is the table showing the top 10 countries with the most number of NFT users:

Country	No. of NFT Users
Thailand	5.65 million
Brazil	4.99 million
United States	3.81 million
China	2.68 million
Vietnam	2.19 million
India	1.50 million
Canada	1.40 million
Indonesia	1.25 million
Germany	1.23 million
South Africa	1.23 million

III. The Philippines is the country with the highest NFT adoption rate.

According to Statista, individuals in the United States, United Kingdom, Canada, and Germany were substantially less likely to own or purchase NFTs in 2022 than people in other countries. Analyzing the results of multiple Google Surveys conducted in 2022 worldwide demonstrates that NFTs are highly popular among Southeast Asian and Latin American folks.

Here is a table showing the countries with the highest NFT adoption rate:

Country	Share of adults who own an NFT
Philippines	32%
Thailand	26.6%
Malaysia	23.9%
UAE	23.4%
Vietnam	17.4%
Nigeria	13.7%
Brazil	12.1%
Hong Kong SAR	10.7%
Venezuela	10.6%
Peru	9.9%
Colombia	8.4%

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Nigeria	13.7%
Brazil	12.1%
Hong Kong SAR	10.7%
Venezuela	10.6%
Peru	9.9%
Colombia	8.4%

South Africa	8.3%
Argentina	7.4%
Singapore	6.8%
Canada	5.6%
Australia	4.6%
Germany	4%
United States	2.8%
United Kingdom	2.5%
Japan	2.2%

2.2. STUDY

Based on the research study by Dalai, S., it can be concluded that cryptocurrency, particularly in the form of non-fungible tokens (NFTs) and blockchain technology, has several positive aspects. Firstly, NFT trading practices were seen as a means to generate additional income by the majority of users. This highlights the potential financial benefits of participating in the cryptocurrency market. NFTs have provided individuals with opportunities to monetize their digital assets and creations, such as artwork, music, or collectibles, by leveraging the uniqueness and scarcity that non-fungibility offers. Secondly, the study indicates that ownership of NFTs can empower individuals by creating ownership structures. By utilizing blockchain technology, NFTs enable verifiable ownership and provenance of digital assets. This empowers creators and collectors by providing them with a sense of control and security over their digital possessions, which was previously challenging to achieve in the digital realm.

Additionally, the study emphasizes the importance of incorporating utility factors and utilizing smart contracts to maximize the value and effectiveness of NFTs. Smart contracts, which are self-executing contracts with predefined rules encoded on the blockchain, enable various functionalities and possibilities for NFTs. This programmability enhances the versatility and usefulness of NFTs beyond simple ownership, potentially leading to new and innovative applications.

Overall, the research suggests that cryptocurrency, particularly NFTs and blockchain technology, has the potential to bring financial opportunities, empower individuals through ownership structures, and leverage utility factors through smart

contracts. However, it is important to note that the cryptocurrency market is still evolving, and caution should be exercised while participating in it due to its inherent volatility and potential risks.

3. Advantages and disadvantages of blockchain

Blockchain technology has garnered popularity due to its promise to transform businesses through decentralized and transparent transactions. Blockchain, with its distributed ledger maintained by a network of computers, has both advantages and disadvantages. In the framework of this discussion, we will look at its effectiveness as well as potential problems, as well as provide insights into the implications and influence of blockchain across numerous industries.

Advantages:

a. **Enhanced Security and Privacy**

Blockchain enhances data security and privacy by creating an unchangeable and encrypted record, safeguarding sensitive information from fraud and unauthorized access. Personal data can be anonymized and access can be restricted through permissions, addressing privacy concerns. Distributed storage across a network of computers makes it challenging for hackers to access data, reducing the risk of unauthorized breaches.

b. **Smart Contracts and Automation**

Transactions can also be automated using "smart contracts," increasing efficiency and speeding up the process even more. When certain requirements are met, the next stage in the transaction or process is automatically initiated. Smart contracts eliminate the need for human intervention as well as reliance on third parties to ensure that contract requirements are honored. Smart contracts and automation in blockchain provide advantages by reducing the need for intermediaries, and increasing efficiency through automatic execution of predefined conditions, resulting in faster and more reliable transactions.

c. **Increased efficiency and speed**

Traditional paper-intensive processes are time-consuming, prone to human error, and frequently necessitate third-party intervention. Blockchain can handle transactions far faster than traditional techniques since it eliminates intermediaries and replaces remaining human processes in transactions. In some circumstances, blockchain transactions can be completed in seconds or less.

Disadvantages:

a. **High costs of implementation**

Implementing blockchain in a business is expensive. Most businesses are hesitant to engage in this technology because of the high cost of capital. If you are a business owner interested in implementing blockchain, you must engage core blockchain developers as well as blockchain

software developers. This will necessitate a significant investment. Following that, you must develop blockchain-based applications. There are further hardware requirements.

b. Scalability Challenges

Scalability issues confront blockchain technology, particularly in public and permissionless networks. The network may get slower as the quantity of transactions increases, resulting in longer confirmation periods and higher transaction costs. Solving scalability concerns while maintaining decentralization is a fundamental technological barrier to mainstream blockchain implementation.

c. Immutability

Data immutability has always been one of the biggest disadvantages of the blockchain. Once information is entered on a blockchain, it cannot be modified. Any inaccuracies or facts simply cannot be updated. This might cause issues with data accuracy, privacy compliance, and legal duties, especially when working with personal or secret information. In scenarios when data needs to be updated or corrected owing to changes in circumstances or legal requirements, the inability to readily amend or remove data might cause issues.

These are the main advantages and disadvantages of Blockchain technology. It is a game-changing method of storing and transporting data. While it has some drawbacks, most of them can be mitigated with proper design and implementation. Because of the current state of blockchain technology, it is the ideal fit for organizations who wish to use its distributed ledger capabilities.

Surveys and Technology Evaluation and benefits

This following collection of case reports explores a range of NFT and crypto investments, showcasing both successful ventures and instances of risk and scams. By examining these cases, the researchers aim to gain valuable insights into the opportunities and challenges present in this technology.

Successful NFT and Crypto Investments

Case I: Erik Finman – Strategic Investment on Cryptocurrency

Erik Finman, known as the "Bitcoin Teenage Millionaire," made a remarkable investment journey starting at the age of 12. He convinced his parents to let him forgo college and pursue a non-traditional education if he could turn $1,000 into $1 million. Erik chose to invest the entire amount in Bitcoin and other cryptocurrencies when their value was just $12 per coin.

His decision paid off when the price of Bitcoin surged to $1,200 per coin two years later. Taking advantage of his success, Erik made a minor investment in an online education startup called Botangle by selling a portion of his crypto holdings. Investors showed interest in the platform, which provided video tutoring services, and offered him the choice to sell the company for either $100,000 or 300 BTC.

To win the bet with his parents, become the youngest cryptocurrency millionaire, and avoid attending college, Erik decided to accept the payment in Bitcoin. He achieved his objective by the time he turned 18, as the value of Bitcoin reached $2,700 in June 2017.

Erik's current estimated net worth is $5 million or more. In 2019, he launched Metal Pay, a website that educates people of all knowledge levels on Bitcoin investment. Overall, Erik Finman's case exemplifies the potential for success in the cryptocurrency market through strategic investment and entrepreneurial ventures.

Case II: Luis Buenaventure - Embracing Digital art through NFTs

Luis Buenaventura, a Filipino artist and crypto entrepreneur, has emerged as one of the most successful NFT artists in the Philippines. His collaborations and artworks have garnered significant attention and success in the NFT space.

One of Luis' notable achievements was his collaboration with Argentinian comic book legend Jose Delbo. They sold 222 editions of their comic book art titled "Satoshi The Creator - Genesis" on the Nifty Gateway platform, each priced at $1,999, totaling over P22 million .Another notable collaboration was with Heart Evangelista and Rodel Colmenar resulting in a multimedia project that earned 17.35 ETH (approximately P3.6 million).

Luis' success as an NFT artist can be attributed to his early involvement in the cryptocurrency industry and his ability to adapt to the evolving NFT market. He emphasizes the importance of understanding cryptocurrency and being comfortable with investing in it. Additionally, he highlights the significance of creating cool, edgy, and unique art pieces that capture the attention of the NFT community. Scarcity, rarity, and promoting one's work in the crypto community, particularly on Twitter, are also crucial factors in achieving success as an NFT artist. Overall, Luis Buenaventura's journey in the world of NFTs showcases the possibilities and opportunities available for artists who embrace digital art and leverage the blockchain technology behind NFTs.

Figure 1. Satoshi The Creator – Genesis

Risks and Scams in Crypto Space

Case III: Ronin Bridge – Highlighting Importance of Decentralization

In late March, the Ronin sidechain, built for the game Axie Infinity, was hacked, resulting in the theft of over 173,600 Ether (ETH) and 25.5 million USD Coin (USDC), with a combined value of over $600 million. The breach was attributed to the compromise of private keys to five validator nodes on the Ronin chain, including a third-party validator run by Axie DAO. The hackers gained access to four out of the nine validators, which is the threshold required to approve a transaction (Prashant, 2022).

The exploit was facilitated by social engineering and human error, as access granted by Axie DAO to Sky Mavis, the developers of Axie Infinity, was not revoked. Sky Mavis, the company behind Axie Infinity, pledged to reimburse and recover the stolen funds.

The hack raised questions about the security and decentralization of the Ronin chain, as well as the validator approval process. In the context of the Ronin bridge, decentralization refers to the distribution of power and control among multiple entities, reducing the risk of a single point of failure or vulnerability.

The Ronin bridge was designed with a limited number of validators, specifically nine validators, responsible for approving transactions and maintaining

the integrity of the network. However, the problem arises when a significant portion of these validators is controlled by a single party, in this case, the developers behind Axie Infinity and the Axie DAO.

By having a majority of validators controlled by a single entity or a small group of entities, the system becomes more centralized. This means that if an attacker gains access to or compromises a significant number of these validators, they can potentially manipulate the network's operation and carry out fraudulent activities, as was the case with the Ronin hack.

The hack on the Ronin chain highlights a combination of human error and social engineering *(manipulation of individuals or groups through psychological tactics to deceive, manipulate, or gain unauthorized access to sensitive information or systems)*. It also exposed potential weaknesses in the design and decentralization of the system. While blockchain technology itself is not to blame, it is crucial to implement robust security practices and continuously improve the system to protect against potential vulnerabilities and attacks.

Case IV: McGlay – Highlighting the Volatility of Cryptocurrencies

During the cryptocurrency boom of the pandemic, Gian Carlo McGlay, A Filipino migrant worker, saw potential in Axie Infinity, a blockchain-based online game that allowed players to earn cryptocurrency called smooth love potion (SLP). McGlay formed a team of players, known as scholars, who rented game characters from managers like him in exchange for a portion of their earnings.

At its peak, the game attracted millions of users, mainly from the Philippines and other developing countries. However, as crypto prices crashed, McGlay faced losses of over 1 million pesos, considering his Axie Infinity assets worthless. Many managers and players experienced similar financial setbacks as the value of SLP tokens plummeted from the highest peak which is P20 to P0.13. Consequently, the game's popularity also declined, and players moved on to other income sources. The volatile nature of the crypto world, as demonstrated by the SLP's ups and downs, serves as a warning for potential investors (Philippine Daily Inquirer, 2023).

On the other hand, From an interview of Cruz (2021) to Joseph Louie Miranda, a crypto trader and Axie Infinity player, emphasized the presence of skepticism towards cryptocurrencies. Miranda encouraged people to educate themselves about cryptocurrencies and understand how they work before dismissing investments like Axie Infinity as scams. Miranda compared cryptocurrency investments to the stock market, explaining that their value increases due to people investing in them. He acknowledged that investing in anything involves evaluating risks, and in the case of Axie Infinity and other cryptocurrencies, risks can never be eliminated due to their volatile nature (Cruz, 2021).

Significantly, the case of SLP and other cryptocurrencies' volatility is not the fault of blockchain technology itself. Since the volatility of cryptocurrency prices is driven by various factors such as market demand, investor sentiment, regulatory changes, and overall market conditions. These factors can cause significant price fluctuations in cryptocurrencies, including Axie Infinity's SLP which is independent of the underlying blockchain technology (Reiff, 2022).

Effects of Cryptocurrency and NFT on several areas

Cryptocurrencies and non-fungible tokens (NFTs) have brought about several impacts and effects across various domains. These effects are evident on the cases featured above and are allowed by the underlying blockchain technology. Here are some key effects of cryptocurrency and NFT:

POSITIVE EFFECTS

1.   ECONOMY AND FINANCE

1.1 Financial Innovation:

Cryptocurrencies have sparked innovation in the financial industry by introducing new forms of digital currency. They have challenged traditional banking systems and provided alternative means of transacting, storing value, and raising capital. A study from Gowda & Chakravorty (2021) summarizes that cryptocurrency transactions are better compared to bank transaction, but it is not aged or experienced as much as banks.

1.2 Disintermediation:

By leveraging blockchain technology, cryptocurrencies and NFTs eliminate the need for intermediaries such as banks, brokers, or record-keepers. This disintermediation reduces transaction costs, enhances transparency, and empowers individuals to have direct control over their financial assets and digital creations.

1.3 Investment Opportunities:

Investors can buy and trade various cryptocurrencies, and NFTS, potentially benefiting from price fluctuations and market trends. In fact, Cryptocurrency markets have skyrocketed in value over the past decade, at one point reaching almost $2 trillion. As of April 2023, Bitcoin was valued at more than $540 billion in crypto markets. However, it's important to note that cryptocurrency investments carry risks, including volatility and regulatory uncertainties (Frankenfield, 2021).

2.   ART AND OWNERSHIP

2.1 Art and Digital Creativity:

NFTs have revolutionized the art world by enabling digital artists to tokenize and sell their creations as unique, verifiable assets. This has created new opportunities for artists to monetize their work by selling their work directly to collectors, bypassing traditional intermediaries such as galleries or auction houses and traditional market value. Furthermore, NFT marketplaces provide global exposure for artists, making it easier for them to gain recognition and expand their reach. (Gruter, n. d.).

2.2 Authenticity and Proof of Ownership:

NFTs solve the problem of provenance in the art world. Each NFT contains a digital record of ownership and transaction history, ensuring the authenticity and provenance of the artwork. This transparent and immutable nature of blockchain technology helps combat issues such as art forgery and theft. (Gruter, n. d.).

2.3 Ownership and Fractionalization:

Cryptocurrencies and NFTs have introduced the concept of fractional ownership to the art market. It allows investors to invest in high-value or rare assets that may have been unaffordable by investing only fractions or shares of high-value artworks. It also provides liquidity, as fractional owners can sell or trade their ownership shares in secondary markets. (Gruter, n. d.).

2.4 Royalty Streams for NFT Artists

NFT technology also enables artists to earn royalties on their work, allowing them to receive a percentage of each subsequent sale of the token after the initial sale. When an artist creates an NFT and sells it, they can include a royalty clause in the smart contract associated with the NFT. This royalty clause specifies a percentage of the resale price that the artist will receive every time the NFT is sold in the future. This empowers creators to benefit from the long-term value of their art and incentivizes them to continue producing and sharing their creations (Gruter, n. d.).

NEGATIVE EFFECTS

3. MARKET AND INVESTMENTS

3.1 Market Volatility:

The volatility of cryptocurrencies can create a highly risky market environment. Prices can fluctuate rapidly, leading to significant gains or losses for investors. This volatility can make it challenging for artists and creators to determine the value of their NFTs and can also lead to financial risks for buyers and sellers (Reiff, 2022).

3.2 Market Saturation:

The increasing popularity of NFTs has resulted in a flood of digital assets being created, which can make it harder for individual artworks to stand out. This saturation of the market can make it challenging for artists to get noticed and earn money from their creations. A new type of inequity in the art world may emerge for those artists who lack the tools

and networks required to produce and market NFTs (Finance Magnates, 2023).

4. SECURITY

4.1 Hacking and Theft

Though cryptocurrency blockchains are highly secure, off-chain crypto-related key storage repositories, such as exchanges and wallets, can be hacked. Many cryptocurrency exchanges and wallets have been hacked over the years, sometimes resulting in millions of dollars worth of "coins" stolen, the same case with the Ronin bridge hacking. Hackers employ various techniques such as phishing attacks, malware, and exploiting software vulnerabilities to gain unauthorized access to these repositories. (Reiff, 2022).

5. ENVIRONMENT

5.1 Huge Energy Consumption

One of the advantages of cryptocurrencies is that anyone can mine them using a computer with an Internet connection. However, mining popular cryptocurrencies require considerable energy, sometimes as much energy as entire countries consume.

For instance, Bitcoin, the largest cryptocurrency, has a significant impact on global energy consumption. Its annual energy consumption is estimated at 150 terawatt-hours, surpassing the electricity usage of entire countries like Argentina. This energy consumption emits around 65 megatons of carbon dioxide annually, comparable to the emissions of Greece. The growth of cryptocurrency mining operations has fueled an increasing demand for energy as companies compete to capitalize on the digital gold rush. The energy consumption of Bitcoin is a significant concern, and projections suggest that crypto miners could add up to 6 gigawatts of energy demand by mid-2023 (Hinsdale, 2022).

Bitcoin mining involves solving complex mathematical puzzles to validate and add new transactions to the blockchain. This requires powerful computational hardware (mining rigs) to perform numerous calculations per second. The computational power required for mining increases over time, leading to higher energy demands. Cryptocurrency proponents say this problem can be solved using renewable energy; El Salvador's president has pledged to use volcanic energy to mine Bitcoin, for example. Environmental concerns reportedly prompted Ethereum's move to a proof of stake model, which uses less energy (Berman & Siripurapu, 2023).

It's worth noting that the impact and effects of cryptocurrencies and NFTs are still evolving, and their long-term implications on various sectors, including finance, art, and environment are still being explored. As these technologies continue to progress, their true potential and impact will become more apparent.

Summary

The research focuses on exploring the applications and functionality of blockchain technology in the context of cryptocurrency and NFTs, specifically within the Philippines. It aims to evaluate the use and impact of blockchain in cryptocurrency transactions and storage, as well as the production, trading, and verification of NFTs in the market. The study seeks to provide insights into the practical implications and benefits of blockchain technology in the specified areas, without extensively analyzing global blockchain landscapes or technical protocols.

Blockchain technology has had a transformative impact on transactions and data management. It gained popularity with the introduction of Bitcoin in 2009. Blockchain's security, immutability, and decentralization have benefited industries like finance, supply chain, and healthcare. In the Philippines, blockchain has driven growth and innovation, particularly in cryptocurrency adoption. The future of blockchain and cryptocurrencies in the Philippines appears promising, with growing interest and exploration of their applications in the financial infrastructure.

Blockchain technology is a decentralized digital ledger used for cryptocurrency and NFT trading. It offers transparency, security, and persistence of transactions while allowing some anonymity. Its architecture includes nodes, transactions, blocks, chains, miners, and consensus algorithms. Blockchain ensures decentralization, auditability, transparency, and security through cryptography. It can be implemented as public, private, or consortium blockchains. Consensus algorithms validate transactions. Research on blockchain includes exploring its history, uses, and functions, analyzing its significance in cryptocurrency and NFTs, and assessing its impact and benefits.

Blockchain technology also offers several advantages, including enhanced security, transparency, and efficiency in recording and verifying transactions. It enables decentralized and secure digital transactions, ensuring the integrity of data through cryptography. Additionally, blockchain's ability to automate processes using smart contracts contributes to increased efficiency and reduced costs. However, there are also disadvantages to consider, such as the high implementation costs and scalability challenges in public networks.

The collection of case reports explores the opportunities and challenges of cryptocurrencies and NFTs. Successful investment cases demonstrate the potential for significant returns and entrepreneurial ventures in this market. However, security risks, market volatility, and the saturation of the NFT market are concerns. Cryptocurrencies and NFTs have brought financial innovation and disintermediation, but also pose risks. It is important for individuals to educate themselves and make informed decisions. Improvements in security, decentralization, and environmental sustainability are needed for the long-term viability of cryptocurrencies and NFTs.

Conclusion and Recommendations

Conclusion

The study conducted entitled LF Scholars: Effectiveness and Security Factors of Blockchain Technology for Cryptocurrency and Non-Fungible Tokens (NFTs) has shed light on the immense potential of blockchain architecture in benefiting the world of cryptocurrencies and NFTs. The architectural factors of blockchain bring several advantages, particularly in terms of effectiveness and security.

Firstly, the decentralized nature of blockchain ensures transparency, immutability, and tamper-proof records, making it highly effective for cryptocurrency transactions. The use of public ledgers, cryptographic algorithms, and consensus algorithms ensure the security and integrity of data, protecting it from unauthorized access and manipulation. This enhances trust among participants and fosters efficient and secure financial transactions.

Moreover, blockchain technology benefits different areas within the cryptocurrency space. For instance, it provides individuals in countries like the Philippines with access to the global financial system, empowering them to participate in investments and economic activities previously inaccessible. The increased interest in blockchain investments, such as cryptocurrencies and NFTs, presents significant opportunities for wealth creation and economic growth.

Additionally, the study highlights the positive effects of blockchain technology on NFT art and digital ownership. It enables artists to authenticate and monetize their creations, while collectors can securely own and trade digital assets. Blockchain's decentralized nature eliminates intermediaries and provides a transparent and verifiable system for provenance and ownership, revolutionizing the art industry

However, it is essential to consider the negative effects associated with blockchain technology. Market volatility poses risks for investors, as the value of cryptocurrencies can fluctuate dramatically causing participants to lose their money or gain exponentially. These successful gains lead to Saturation in the market which poses challenges in standing out assets potentially impacting their value. On the other hand, the risk of hacking, scams, and theft remains a concern, requiring robust security measures to protect digital assets.

As all these blockchain activities happen, perhaps the most alarming environmental impact of blockchain mining also worsens. The energy consumption associated with blockchain operations, particularly for proof-of-work consensus algorithms, raises sustainability issues. The significant energy requirements contribute to carbon emissions and environmental degradation, requiring attention and mitigation strategies.

Recommendations

To balance progress, sustainability, and security in the blockchain ecosystem, this research recommends several solutions:

1. **Transition to more energy-efficient consensus mechanisms:** This study encourages blockchain companies and developers to explore alternative consensus algorithms, such as proof-of-stake, or any other that can significantly reduce the energy consumption associated with blockchain mining. This transition would help address the environmental concerns while maintaining the security and integrity of the network.

2. **Responsible Investment:** This encourages people for responsible investment practices, such as conducting thorough research, diversifying portfolios, and understanding market dynamics. These pieces of information can help individuals make informed investment decisions and reduce the likelihood of falling victim to scams and market volatility.

3. **Education and awareness programs**: Researchers encourage universities, government, and any industry-related institutions to spread awareness about the potential risks and rewards of blockchain investments. Educating users about market volatility, security best practices, and responsible investing can guide individuals make informed decisions and mitigate potential losses.

4. **Government funding on Innovation and Research**: This study encourages the Government body to implement and support research and development in blockchain technology by providing funding, grants, and incentives to promote innovation. Governments can also collaborate with industry stakeholders and academic institutions to explore the potential applications of blockchain in various sectors.

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