International Journal of Innovative Social Sciences & Humanities Research 12(1):120-143, Jan.-Mar., 2024

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Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities in Rivers State.

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ABSTRACT
The study examined Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities. Two objectives and two hypotheses were formulated to guide the study. A descriptive survey design was adopted. The Population of the study consisted of all the 2815 lecturers in public universities in Rivers State. The sample of this study comprised 411 respondents using stratified random sampling. The instrument that was be used for data collection was be self-designed questionnaire titled: Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities Questionnaire. The findings revealed that there The findings of the study showed that the use of blockchain technology in academic research can enhance data security and prevent unauthorized access to research findings; enhance the credibility and reliability of academic citations and references, mitigating issues of plagiarism and academic misconduct; enable the creation of decentralized academic publishing platforms, empowering researchers to have greater control over their own publications; can foster greater trust and collaboration between universities, researchers, and funding bodies; can provide a secure and immutable record of researchers' contributions, enabling fair recognition and attribution in academicsThe study recommended amongst others Conduct a comprehensive feasibility study to assess the readiness and potential benefits of implementing blockchain technology in the intellectual property commercialization process within public universities. Collaborate with industry experts, legal professionals, and technology specialists to develop robust smart contracts that automate licensing agreements, royalty payments, and intellectual property transactions on the blockchain.
Keywords: Innovation, Intellectual Property, Commercialization, Models, Blockchain Technology.

INTRODUCTION

Blockchain technology has emerged as a revolutionary tool with the potential to transform various industries, and the field of intellectual property commercialization is no exception. Public universities, as centers of innovation and research, can greatly benefit from adopting blockchain technology to enhance the efficiency and transparency of their intellectual property commercialization models.

Blockchain technology, known for its decentralized and immutable nature, provides a secure platform for recording and verifying transactions. When applied to intellectual property rights, blockchain can enhance the efficiency and transparency of commercialization processes. By creating tamper-proof records of ownership, licensing agreements, and royalty payments, blockchain ensures the integrity of intellectual property transactions while reducing the risk of disputes and infringement. In public universities, where research and innovation generate a significant amount of intellectual property, blockchain technology can

streamline the commercialization process. Researchers can securely register their creations on the blockchain, establishing a clear chain of ownership and facilitating licensing agreements with external partners. Moreover, smart contracts self-executing agreements coded on the blockchain can automate royalty payments and ensure compliance with licensing terms, enhancing the overall efficiency of intellectual property management.

Böhme, et al (2015) averred that, the traditional process of intellectual property commercialization within public universities has been characterized by various inefficiencies, including lengthy legal procedures, lack of transparency, and the involvement of intermediaries. Blockchain technology, originally designed as a decentralized ledger for cryptocurrencies, introduces a novel paradigm that has the potential to streamline and enhance the entire IP commercialization process. By leveraging blockchain's core features such as transparency, immutability, and decentralization, universities can create a more efficient and secure ecosystem for managing intellectual property. Blockchain's transparent and tamper-resistant nature ensures a trustworthy record of the entire intellectual property life cycle, from creation to commercialization. This transparency not only reduces the risk of disputes but also fosters trust among stakeholders, including researchers, investors, and potential commercialization partners. Additionally, the decentralized nature of blockchain eliminates the need for intermediaries, reducing associated costs and accelerating the IP commercialization timeline. the integration of smart contracts within blockchain technology holds immense promise for automating various aspects of intellectual property agreements. Smart contracts are self-executing contracts with the terms directly written into code, ensuring automated and irreversible execution of predefined actions when specific conditions are met. This feature can significantly expedite the licensing and transfer processes, making IP commercialization more agile and responsive to market demands.

Swan, (2015) stated that utilizing blockchain technology, public universities can create a decentralized ledger that records all transactions related to intellectual property rights. This ledger can be accessed by relevant stakeholders, such as researchers, inventors, and potential commercial partners, ensuring transparency and accountability throughout the commercialization process. Additionally, the use of smart contracts on the blockchain can automate certain aspects of the commercialization process, such as licensing agreements and royalty payments, further streamlining the process and reducing administrative overhead.

Catalini,, & Gans, (2016) argued that , the adoption of blockchain technology in intellectual property commercialization offers several benefits to public universities. These include increased transparency, reduced administrative costs, enhanced security, and improved traceability of intellectual assets. By leveraging blockchain, universities can attract more industry collaborations, facilitate technology transfer, and generate additional revenue from their intellectual property portfolio. However, the implementation of blockchain-based models in public universities also poses certain challenges. These may include regulatory uncertainties, technical complexities, interoperability issues with existing systems, and concerns regarding data privacy and confidentiality. Overcoming these challenges requires a collaborative effort among stakeholders, including academic institutions, government bodies, industry partners, and legal experts, to develop robust frameworks and standards for blockchain adoption in the intellectual property domain. The integration of blockchain technology in intellectual property commercialization models has far-reaching implications for public universities. By embracing blockchain, universities can enhance their competitiveness in the innovation landscape, foster a culture of collaboration and transparency, and effectively capitalize on their intellectual assets. Moreover, blockchain has the potential to revolutionize traditional models of intellectual property management, paving the way for new revenue streams and partnerships in the knowledge economy.

Technology is a consistent cause of innovation across all eras, advances in technology have brought about modernization, affecting performance in all fields such as education, health, the economy, and all others. The impact of the industrial revolution on innovation and technology are the driver of economic, political. Social and educational development. It reinforces the propensity to accelerate change and technological innovation is the application of know how tools techniques and methods aim to providing solution to

problems. Blockhain technology is an innovation which has been used in a diverse array of fields such as finance education, health and the economy amongst several others.

Blockchain technology being one of the most current developing technologies, offers alternative answers to many challenges in various sectors because to its qualities such as trust, transparency, immutability, self-sovereignty, and provenance. The educational sector is undoubtedly one of them, the issues of documentation and record keeping is best stored in the blockchain technology where it cannot be tampered or altered, researchers intellectual properties is well secured in this technology and you cannot plagiarise without acknowledging the author of the article. Blockchain technology assists in the authenticity and transparency of multicomponent transactions. It can improve data transfer procedures, lower administrative burdens, and ensure secure transactions. Blockchain technology can assist with contract administration and documentations. There are different types of blockchains technology, they are: Public Blockchains a public blockchain is a network of open, decentralized computers that anyone can access to request or verify a transaction and documents (check for accuracy and facts). Transactions are validated by miners, or smart contract computers who are rewarded. Consensus mechanisms used by public blockchains include proof-of-work and proof-of-stake**.**

Utilization is viewed as the degree of usage of existing preferences; while preference could be service rendered, data, resources or an object, the available resources should be utilized in such a way that it enables the organization to acquire desirable competencies. resource utilization as viewed by the researcher in the present means the ability of organization to comfortably access, operate and make use of the available resources in order to promote innovations and achieve organizational objectives. The term utilization simply refers to the organization's actual use of the resources, technology, and materials. Utilization is asserted as the practice of utilizing access to information at one's disposal. Something is comparable to or fully sufficient for a specified or implied demand if it is utilized. It also refers to how resources are allocated in order to achieve desirable outcomes. Utilization simply represents the actual patronage of the facilities, equipment and supplies by the organization. Furthermore utilization as the act of making use of available services at the individual's disposal, utilization is that something is equal to or fully sufficient for a specified or implied requirement. It also means how resources are used to get good results and explore available technology.

Gabriel (2019) conceived commercialization of as a process by which a new product or service is introduced into the market for the utmost satisfaction of the consumers. Commercialization is a product of privatization. By implication, nongovernmental organizations, interested and equitable stakeholders can freely participate and contribute to the development of the educational system. It has been universally acknowledged that in the products and adapting new methods upon their existing product despite the existing goods and services. commercialization is the process of converting novel ideas, inventions and knowledge into bigger capital for persons, enterprises and communities at large with the purpose of gaining maximum profit by investing on research, production, licensing and marketing for the target market.

World intellectual property organization (2022) defined Intellectual property (IP) refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce. Intellectual Property Rights are legal rights, which result from intellectual activity in industrial, scientific, literary & artistic fields. These rights Safeguard creators and other producers of intellectual goods & services by granting them certain time-limited rights to control their use. Protected IP rights like other property can be a matter of trade, which can be owned, sold or bought, these are intangible and non-exhausted consumption.

The university digital economy has also had a significant impact on research commercialization, enabling universities to transform their research outputs into innovative products and services. Digital technologies have opened up new avenues for commercialization, allowing universities to reach new markets and create new revenue streams. One of the key drivers of research commercialization in the university digital economy is the availability of data. Digital technologies have made it easier for universities to collect,

store, and analyze vast amounts of data, leading to new insights and discoveries. This data can be used to develop innovative products and services that meet the needs of businesses and consumers.

Statement of the Problem

In today's global knowledge-driven economy, universities are increasingly acknowledged as crucial drivers of innovation and economic progress. The process of turning intellectual property into commercial assets has become a significant means through which universities contribute to economic development. This involves transferring knowledge, generating income, and creating employment opportunities. However, traditional models for commercializing intellectual property have faced criticism for being inefficient, lacking transparency, and causing disparities in the distribution of benefits among those involved.

A promising solution to these challenges involves implementing blockchain technology in the intellectual property commercialization efforts of public universities. Blockchain technology provides a decentralized, secure, and transparent platform for managing digital assets, including intellectual property. By utilizing the distinctive features of blockchain, public universities can improve the efficiency, accountability, and fairness of intellectual property commercialization processes. This, in turn, promotes innovation, economic growth, and societal well-being.

Despite the potential advantages of integrating blockchain technology into intellectual property commercialization in public universities, there are notable challenges and obstacles to overcome. These include legal and regulatory issues, technical complexities, cultural resistance, and a lack of awareness and understanding of blockchain technology among key stakeholders. Additionally, there is a need for comprehensive research to assess the effectiveness and impact of blockchain-based intellectual property commercialization models in the context of public universities.

Aim and Objectives of the Study

The aim of this study is to determine the Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities. Specifically, the objectives are to

1. examine how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State
2. examine the commercialization strategies utilized in Universities in Rivers State

Research Questions

The following research questions were stated to guide the study

1. How can blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State?
2. What are the commercialization strategies utilized in Universities in Rivers State?

Hypotheses

The hypotheses tested at 0.05 level of significance guided the study.

$H0_1$: There is no significant difference between the mean scores of male academic staff and female academic staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State.

$H0_2$: There is no significant difference between the mean scores of male academic staff and female academic staff on how commercialization strategies utilized in Universities in Rivers State

LITERATURE REVIEW

Conceptual Framework

The Conceptual of Blockchain Technology

Blockchain technology is a new and emerging technological trend which has permeated almost every sectors, blockchain technology has be able to help in accurate record keeping and sincere transaction, making data storage safe and combing out double standard. Blockchain technology is a system of recording information in a way that makes it difficult or impossible to change, hack or cheat the system. Joseph & Paul (2018) stated that blockchain technology cannot be controlled by any single entity nor does it have a single point of failure. By storing data and information across its network, the blockchain

eliminates the risks that come with data and information being held centrally. Blockchain networks lack centralized points of vulnerability that computer hackers can exploit easily. To strengthen security, blockchain tends to make use of encryption technology, Blockchain technology has formed the backbone of the new Internet by allowing data and information to be extensively distributed.

Though blockchain technology was designed for the digital currency Bitcoin, it has a broad array of applications in the commercial and technological worlds. Not only programmers, but all corporations, will need to understand the modern technology. Blockchain technology will alter business models in a variety of industries and may even alter how people work and live. Blockchain technology are linkage of programmed blocks. The blocks are created to be immune to modification once they have been recorded, the data and information in a block cannot be changed later, a public blockchain database is managed autonomously via a peer-to-peer network and a distributed time stamping server. Blockchains are a type of open, distributed ledger that can efficiently and permanently record transactions between two parties.

The name blockchain stems from the way transaction data is stored in blocks that are connected together to form a chain. The blockchain grows in size as the number of transactions increases. Within a discrete network governed by rules agreed upon with the participants in the network, blocks record and confirm the time and sequence of transactions, which are then logged into the blockchain. Each block contains a hash (a digital fingerprint or unique identifier), timestamped batches of recent valid transactions, and the hash of the previous block. The prior block hash connects the blocks and prohibits any of them from being modified or inserted between two other blocks. As a result, each successive block reinforces the prior block's verification, and hence the entire blockchain. The technology makes the blockchain tamper-evident, which contributes to its core characteristic of immutability. The blockchain contains transaction proof that has been verified, blockchain is a database for recording transactions, and it offers considerably more advantages than a standard database recording.

The ledger can also be designed to automatically launch transactions. Blockchains are a type of distributed computing system with significant byzantine fault tolerance and are secure by design. As a function, a blockchain can establish decentralized consensus. These characteristics make blockchains excellent for documenting events and other records management operations, identity management, transaction processing, and a variety of other new applications. Nevertheless, blockchain technologies enable large-scale and systematic collaboration on a distributed and decentralized basis. Ledgers are also not new; double-entry bookkeeping has utilized them since the 13th century, what is novel is the concept of a shared, distributed ledger, which would be an immutable record of all network transactions that can be accessed by all network participants. Transactions are only recorded once in a shared ledger, removing the duplication of effort that is prevalent in organizations.

Ricardo & Albérico, (2021) viewed Blockchain as perceived as a revolutionary technology offering considerable impact on a vast magnitude of sectors which enables the creation of decentralized. Blockchain technology is a shared, distributed ledger that makes things simpler to record transactions and track assets. A tangible asset, such as a house, car, cash, or land, or an intangible asset, such as intellectual property, such as patents, copyrights, or branding, are examples of assets. On a blockchain technology, virtually anything of value may be recorded and sold, lowering risk and costs for all parties involved. Applications programmed to run on network and records sets of data that can be shared securely without third-party mediation.

It's believed that Blockchain technology priority on variety in terms of applications stems from its ability to create a trusted and decentralized contract environment. Mougayar (2016) argues that blockchain is not just any new technology, but that it is a type of technology that challenges other existing software technologies, because it has the potential to replace or supplement existing practices. The significance of blockchain technology is that it breaks the past paradigm of having a central authority determine how people connect and what data they share. In the past, your e-mail provider or your cell phone carrier provided the public network that allowed you to send communications. With blockchain technology, computers connect directly to transmit encrypted messages to each owner.

No central authority exists to broker the communication. Concerns about privacy, security, and sharing of personal information are why one would look to blockchain technology. Blockchain is a distributed ledger that is recorded and monitored by a decentralized network of independent computers, enabling anybody to verify that the record is complete and uncompromised. Drescher (2017) states that the core problem that blockchain solves is to achieve integrity and trust in a distributed system in the worst of all conditions. A blockchain maintains its integrity with a special algorithm embedded into a common piece of software run by all the computers in the network. The algorithm consistently steers the computers toward a shared consensus on what new data can be added to the ledger. Each computer updates its own version of the ledger independently but does so following a consensus algorithm. Once the new ledger entries are introduced, special cryptographic protections make it virtually impossible to change the entry.

A guiding principle of a blockchain technology is that no object of value can be duplicated. So, when a file is transferred on a blockchain, the original document is transferred. A second principle of a blockchain is that it permanently records transactions in a way that cannot be altered, erased, or hacked. Data on a blockchain can only be sequentially updated and therefore it keeps a permanent historical trail. In this way, a blockchain is like a database that is only ever updated and never overwritten. Bowen (2013) speculates that using blcokchain technology can address the problems of traditional education. Internet-based university education promotes a hybrid model to serve more students with education, which often happens in environments outside the traditional classroom. Organizations deliver specialized training, skill assessment, and professional certification. Often organization training and certification is on par with university standards. In addition, vocational training and industry credentials are recognized as attainment of expertise in a subject.

Mikroyannidis & Bachler (2018) argue for a blockchain technology offers a learner-centered approach for lifelong learning where educational content and training services combine to shape a career trajectory. A decentralized platform that recognizes the validity of corporate training alongside the traditional approach to education would provide a platform for learning bodies to collaborate and deliver a tailored learning path supporting a lifetime career. Blockchain technology can support a hybrid model that supplements traditional higher education with verified coursework from outside institutions. Students can customize a program to create new models of learning. Open Learn University and Future Learn are two systems that support hybrid education on blockchain technology. Casey & Vigna (2018) believe blockchain is capable of supplanting the current outdated model of trust management upon which societies and economies have functioned in the past. They see blockchain as a social technology, a new blueprint for how to govern communities. Because the blockchain is democratic, there is no one entity that owns it. The move to independence is contrary to the way centralized autocratic educational institutions work today.

Blockchain technology has decentralized, transparent, and immutable properties. Widayanti .Harahap, & Lutfiani. (2021) states that development of blockchain from year to year has essential events such as in 2008 Satoshi Nakamoto sparked blockchain technology as a component of bitcoin. In 2009 the technology was developed as a valuable ledger as transactions in a network, with the development of blockchain technology known as blockchain 2.0. In 2014. The blockchain was used as a programming language in conducting transactions such as making transactions more straightforward for users to record with. Using smart contracts with automated system processes can issue receipts or invoices in payments between interested parties by sharing shareholder profits with smart contracts without third parties. And the development of blockchain technology in 2016 has been implemented in an automatic voting system. Bozkurt & Ucar (2021) Blockchain is a ledger featuring computer-processed data records that do not have a single entity (presence), and the data blocks are linked by cryptographic principles for security (e.g. chains). In the form of records in a ledger that can be shared or read without being able to change the data because the data is transparent, blockchain has a network that is not allowed by the control centre as (democratization). With the performance of the blockchain already upsetting the industrial sector, it is clear that blockchain technology does requires authority to function.

The most fundamental advantage of Blockchain technology is decentralization, which enables disintermediate, peer-to-peer transactions. Furthermore, it facilitates distributed ledger coordination by decentralizing control amongst individual nodes using techniques including time-stamping, economic incentive methods, data encryption, and a distributed consensus algorithm.

Swan (2015) viewed Blockchain technology is radically reshaping the behaviour models of organizations and individuals. Trust-free systems make use of the clue to utilize Blockchain technology to automatically generate records of transactions executed in the past that are publically available, unchangeable, and consensual that are administered by the entire system hence mitigating issues related to trust in the systems. Greiner & Wang, (2015). Education's use of Blockchain technology for creating a worldwide evaluation platform to make available facilities for data storing and degree management. There are institutes and organizations teaming up for various educational purposes like the creation of digital badge and identities for online learning based on Blockchain technology. Skiba, (2017). The blockchain technology consist of a sequence of blocks holding a complete list of transaction records arranged in a chronological order, just like a conventional public ledger. Lee, (2015). Each block points to the immediately previous block through a reference consisting of hash value of the previous block called parent block.

The most significant advantage of blockchain technology is that it can execute transactions in a trustworthy manner. Researchers and users can execute records and data transactions directly using smart contract terms without the need for human intervention, dramatically improving data use efficiency. As a modern version of trust structure, blockchain decentralization technology has revolutionized several organizations that previously relied on centralization to build confidence. Whenever the trigger conditions are met, the smart contract will read the input and compute according to the established logic, before permanently storing the calculation results in the network structure. The management of educational records and conducting research are two of the most important applications of ICTs at universities. Strimbei (2016). In recent years, the way universities currently maintain student educational records and research conducted by some lecturers using current types of technology has come under increased scrutiny.

Jirgensons & Kapenieks (2018), educational records frequently do not include information regarding a student's skills, mastery level, or extracurricular activities, and so do not represent all important information needed in today's competitive environment. Many university systems, as pointed out by Turkanovic (2017), are set up in such a way that educational records and research results are stored in databases that are only accessible by students and employees of one university, resulting in a lack of interoperability. In today's modern world, where students and lecturers are increasingly moving between nations to obtain several degrees, and conduct researches this can lead to further issues. Because educational records must be transferable between institutions, paper certificates, publications, and research require additional verification effort because they can be falsified or modified, this is where the utilization of blockchain technology becomes of utmost important.

Grech & Camilleri (2017) The blockchain technology has sparked a surge of interest, with the purpose of addressing the difficulties of growing academic mobility among students and lecturers, changing learning objectives, and improving administrative responsibilities related to the management of these educational records and articles. Blockchain technology is a decentralized data system that can be used to hold any form of asset or value, including intellectual property, certificate, researches, and identities, while maintaining the highest levels of security, trust, and reliability. Open Data Institute (2016) The concept of blockchain technology is premised on a shared, decentralized, and distributed ledger which can be used to record any type of transaction across several computers (also called a peer-to-peer network). On a blockchain technology, transaction data is stored in blocks, with each subsequent block containing a reference to the previous block's hash (identifier), thus connecting them in a chain. Gupta (2017) a blockchain entry is permanent, transparent, and searchable, and it can be used to keep track of anything. Immutability refers to the property of being unchanged over time. Immutability of blockchain technology

offers increased transparency, data consistency and integrity meanwhile preventing data forgery and theft. Boucher (2017).

Blockchain technology allows researchers and scholars in university to register their contributions in a way that they do not fear that they will be taken advantage of without due recognition which will financially benefit the university and the authors. The Blockchain technology is a distributed, encrypted database that records data, or in other words, it is a digital ledger of any transactions or contracts which must be independently recorded. One of the most crucial attributes of Blockchain is that this digital ledger may be accessed from hundreds of thousands of machines and is not limited to a particular location. Geun-Hyung. (2021) pointed that a blockchain technology is a public registry of who owns and who transacts what. The transactions are secured through cryptography, and the transaction history gets locked in blocks of data that are then cryptographically linked together and secured. This creates an immutable record of all the transactions across this network that cannot be forged. The record is replicated on every node in the network. Unlike the existing Internet, blockchain technology enables users to deliver value without relying on a third party. As of now, it has been used to deliver various economic values such as cryptocurrency, stocks, computing resources, real estate, automobile use rights in a shared economic society, and intellectual property rights. A node is simply a computer on the blockchain technology network that stores the ledger.

Chen, Xu, Lu, & Chen (2018) pointed that blockchain technology is characterized by decentralization, traceability, immutability, transparency and can handle currency properties. These technical features can lead to systems with specific advantages in terms of Reliability, Trust, Security and Efficiency. What blockchain technology really offers is a fast, secure, valid, and unquestionable way to make transactions, as well as a reliable distributed control mechanism, which eliminates any possible breach, both because the data is public and because the encryption method is virtually inviolable. Although the first application of blockchain technology was about digital currency (Bitcoin), its usefulness is no longer limited to cryptocurrencies or the field of economics. Blockchain, especially in its last stage v3.0, has many applications in various sectors such as: e-government, e-voting and elections, but also digital identities, for obvious reasons of security and avoidance of violation or change.

(a) Insurance, secure keeping of registers and records, such as the land registry, property registry,
(b) Tax office, company accounting,
(c) Health, secure keeping and exchange of medical records,
(d) The food industry and the supply chain to record all information about an animal or food, from breeding / production to final sale,
(e) Transport, for the organization and monitoring of data and products,
(f) Autonomous driving, payment of tolls, refuelling and drones,
(g) Certification of various products and services,
(h) Management of intellectual property issues such as the distribution of fees or usage rights but also for the immediate payment of the relevant fees directly by users,
(i) The audio streaming industry for the accurate recording of the movement of each song, and, through smart contracts, the attribution of copyright to artists,
(j) The digital art market for the certification of the authenticity of digital works. NFT (Non-Fungible Token) technology, a form of token used in the Ethereum, blockchain, has been developed in this direction and, of course,
(k) Education and Administration. Chen, Xu, Lu, & Chen (2018)

Grech & Camilleri (2017) blockchain technology has seen a significant growth as it is used for permanent protection of certificates, for automatic recognition and transaction of credits, to maintain a lifelong training passport, to verify the multi-stage accreditation, to track intellectual property, to identify or to receive payments from students and to provide financing of students, record and store articles and publications, keep accurate financial transaction in the university, record accurate number of students admitted and graduated, can be used to send study transcript to other university.

Confidentiality, integrity, and non-repudiation of the sent information are perhaps the three factors that are most important to maintaining confidence in the digital era. Confidentiality, according to Tapscott & Tapscott (2016), denotes that data is not disclosed to unapproved people, organizations, or systems. Information must be kept accurate and full throughout its life cycle to be considered to have integrity. The data cannot, therefore, be altered in a way that would be noticed or illegal. Non-repudiation means neither the sender nor the recipient may dispute sending or receiving the transaction, respectively. In an effort to give security and legitimacy to the economic, political, social, and cultural exchanges that take place in the virtual world since the development of the Post-Industrial Society, or what is now known as the Digital Society, a number of efforts have emerged.

Selwyn (2018) industries utilizing blockchain technology, including education. Technology advancements have been crucial in recent years in rethinking education. Many schools have looked for ways to employ technology to address issues including content distribution and reach, recommendations, early intervention, assessments, credential issuance, and verification. These solutions range from e-learning systems to data-driven methodologies.

Ocheja, Flanagan, & Ogata, (2018) state that different institutes often adopt different technologies to manage academic records and issue credentials. This heterogeneity of systems across schools makes it difficult for students to import their learning data from one school to another in a tamper-proof and protected environment. Also, instant verification of academic credentials becomes more complicated as each credential must be validated against a set of rules defined by each school through the specific interfaces provided by such schools or the consortium they belong to. Consequently, it becomes desirable to solve these problems, schools can easily connect and exchange information with little or no change to internal technology setup while maintaining trust and tamper-proof records management. This is one scenario where the blockchain technology fits as a solution in education. Other aspects of education that blockchain technology brings some innovation to include academic research, reputation, e-portfolio, and intellectual property , connecting lifelong learning and learning analytics platforms, credits, credentials, certificates, articles, publications and seminars.

Awaji, Solaiman, & Albshri (2020), asserts that, many top tier universities have already relied on blockchain technology for various functionalities. For instance, an open standard, Blockcerts, has been developed by Massachusetts Institute of Technology Media Lab and Learning Machine for issuing and verifying certificates. The aim of Blockcerts is to prevent a war of standards that could require the use of particular suppliers and their proprietary standards by educational institutions and other organisations. The State University of New York (SUNY) aggregates learning services using technologies focused on Blockchain's peer-to-peer technology from its constituent universities and allied institutions. Finally, San Jose State University is a pioneer in the 'Library 2.0 revolution' and uses blockchain to more effectively handle its libraries. This involves areas such as listing physical and digital books and manuscripts, authenticating library members, and keeping up with members with automatic reminders to return books.

Lam & Dongol (2020) three basic principles are involved in blockchain technology: transaction, block and chain. The transaction is a ledger process, such as the data entry, which often leads to a change in the ledger's status; the block tracks the outcomes of all transaction data over a period; the chain is a chronological string of clocks that represent all the ledger's changes. To ensure full data integrity and availability, blockchain architecture guarantees the following key concepts:

a. **Data Immutability:** Once data is stored it cannot be deleted or modified.

b. **Shared Ledger:** A network where all member has an immutable copy of all transactions.

c. **Consensus:** Mechanism used to achieve agreement on a piece of data between all members of the network.

d. **Permissions:** Blockchain technology can either be permissioned or permissionless, meaning that members of a blockchain either have restricted access on a blockchain or do not. Lam & Dongol (2020)

A blockchain technology is essentially a distributed database of records or public ledger of every digital event or transaction that has ever taken place and been shared among involved parties. A majority of the system's users must agree on every transaction before it can be recorded in the public ledger. Information

can never be deleted after it has been submitted. Every transaction ever done is recorded in the blockchain technology, making it definite and verifiable. Due to its ability to lower security concerns, eradicate fraud, and increase transparency previously, blockchain is an extremely revolutionary and exciting technology. Blockchain technology has subsequently developed into a management and education solution for all varieties of international enterprises, despite its early associations with cryptocurrencies and non-fungible tokens (NFTs) in the 2010s. Lam & Dongol (2020)

Blockchain technology has the potential to transform the way we manage data and ownership in general, safeguard healthcare data, revolutionize researches, and give transparency for food supply chains. Cryptocurrencies (like Bitcoin) and other digital information (documents and certificate) may be transferred freely between individuals without the intervention of a third party using blockchain technology, sometimes referred to as distributed ledger technology, or DLT.

A transaction is concurrently verified by many network nodes using blockchain technology. Anyone with a computer may sign up for the network and take part in transaction validation. The transaction is saved as a code block across several devices, and numerous devices authorize the transaction. Every additional transaction is added to a chain (hence, blockchain) to preserve a historical record on the DLT (thus, distributed ledger), thereby eliminating the danger of hacking. Blockchain technology is so tempting because it allows for this safe manner of transmitting data without a third party. Krdzalic (2021).

Blockchain Benefits

Krdzalic (2021) averred that whenever it concerns blockchain technology, there most important benefits to consider such as:

Decentralization

Decentralization is a significant feature of blockchain technology, among other features. Resistance to censorship and immutability are two of the most important features of decentralization. According to research, one of its unique aspects is the lack of reliance on a third party for the security and safety of an individual's valuables or property. Furthermore, due to the circularized and decentralized characteristics of blockchain technology, the government or copyright offenders would be unable to get through the personalized ledger designed for personal use. The built-in proof-of-work capability assists computing in resolving a wide range of mathematical problems. Furthermore, proof-of-work is a well-known consensus technique that is now being used to reconcile millions of decentralized nodes, ensuring the safety of assets and intellectual property. There are a few key terms that demonstrate the crucial characteristics of decentralization integrated into blockchain technology, such as the potential utility of automation, data redundancy, and peer engagement in development, as well as variety. Krdzalic (2021).

Blockchain technology does not keep any of its information in a single location. Instead, a network of computers copies and spreads the blockchain. Every computer on the network updates its blockchain to reflect the addition of a new block to the blockchain. Blockchain technology makes it more difficult to tamper with data by distributing it across a network rather than holding it in a single central database. If a hacker obtained a copy of the blockchain technology, only a single copy of the data would be compromised, rather than the entire network. A decentralization storage platform is better than a centralized storage platform in handling the issues of data storage and sharing. To proffer solution to a single-point failure, the decentralization storage platform makes sure that no single server controls the entire service. Records and data is distributed and stored in peer-to-peer interconnected storage. The peer-to-peer network can work smoothly so that end users can access the data at anytime and anywhere. In the decentralization platform, the user retains ownership of his/her record and data, thus being the only one to access his/her record and data or permit other users access. Krdzalic (2021).

Decentralization onsists of data integrity verification, data encryption, data decentralization functionality with blockchain technology. Blockchain technology is a collection of data-containing digital blocks. By using cryptographic techniques, the data chain is constructed so that every block is irrevocably connected to the one before it. As a result, if a block is altered, all the blocks after it must also be updated for the chain to continue to be legitimate; otherwise, all blocks after the changed block would be invalid. Hinz, Schiereck, Gomber, & Nofer, (2017) Blockchain technology, at its core, is a distributed ledger that stores

and verifies data and information. There is a guarantee that all information and transactions that have been recorded are accurate and undeniable since this ledger is open to the public and, as was already said, cannot be changed. The key distinction between it and conventional ledgers and databases is that the so-called nodes, or users, who have installed the necessary software, manage the system instead of a central authority. As a result, the registry on a blockchain technology platform is distributed rather than kept in a single location. This allows it to be updated simultaneously by all nodes and to be maintained by all nodes simultaneously.

Trust

The decentralized technique of blockchain technology hides the most important feature of the system. To be more specific, the network is secured so that only a few key members have the authority to validate transactions. Other members can still validate their transactions before validation is implemented; these essential members should have access to the agreement. Furthermore, centralized configuration methods are ensured in the event of private blockchain. Furthermore, only a single body is authorized to make decisions, as well as the authoritativeness of acts and management of the transaction validation process. According to a study, the centralized authoritative member will ensure that the recommended consensus will be the only one followed. This is comparable to the formation of any centralized institution, such as government agencies that serve multiple states. Krdzalic (2021).

Transparency

The majority of blockchains technology are made up entirely of open-source software. This means that anyone with access to the internet can look at the code. This allows auditors to check the security of records and data. This also implies that no real authority exists over who controls data code or how it is modified. As a result, anyone can suggest system improvements or changes. Records and data can be upgraded if a majority of network users agree that the new version of the code with the upgrade is sound and valuable. It is impossible to tamper with any transaction on the blockchain technology. If any transaction is wrongly executed, a new transaction must be issued to right the wrongs of the previous transaction. Krdzalic (2021).

Secure Transaction and Data

The blockchain technology network must verify the legitimacy of a transaction after it has been recorded. Thousands of computers on the blockchain scramble to verify that the purchase's data are correct. The transaction is added to the blockchain technology block after it has been validated by a computer. Each block on the blockchain has its own unique hash, as well as the hash of the previous block. The hash code of a block changes when the information on it is changed in any way; however, the hash code of the block after it does not. This discrepancy makes it extremely difficult for information on the blockchain to be changed without notice.

The ability of blockchain technology to ensure the irreversibility of transactions and recorded data is known as security. It accomplishes this by requiring network participants to engage resources in order to obtain rewards. The blockchain technology becomes more secure as network participants engage more resources. It also refers to a blockchain's level of defensibility against attacks from outside or external sources. Internally, or within the blockchain technology itself, it is a measure of how resistant the system is to change.

Neon-Vest (2018) the primary benefit of robust security is that the blockchain technology is less vulnerable to attack. It improves the traceability and the transparency of the data stored in the blockchain. The security of the transactions is achieved through public key cryptography. Every network participant has public and private keys to encrypt the data and issue digital signatures.

Accuracy of the Chain

A network of thousands of computers authorizes transactions on the blockchain technology. This virtually eliminates human intervention in the verification process, resulting in lower human error and a more accurate record of data. Even if one of the computers on the network makes a computational error, it would only affect one copy of the blockchain technology. For that error to spread to the rest of the blockchain technology, it would need to be made by at least 51% of the network's computers a near

impossibility for a large and growing network the size of records and data. All records in the whole network cannot be tampered and any falsification can be detected easily. Krdzalic (2021).

Types of Blockchain Technology

Generally, blockchain technology is classified into three main types: public, consortium (hybrid) and private.

Public Blockchain Technology

A public blockchain technology is one where the participation is available to anybody, and the network is defined as the blockchain's connected computers. In a public blockchain technology, no single entity has control over the network, making it highly distributed. Because the public blockchain technology is interconnected, each participant has the same set of rights and privileges. These include giving each participant equal authority rather to granting centralized authorization to a third party. Meanwhile, every party or stakeholder has the freedom to enter or leave the network. This feature is cost-free for every participant, and the validation of transactions can be performed by any source. - Public blockchains have no single owner; they are publicly accessible; their consensus process is open to everybody; and they are completely decentralized.

A public blockchain can be used to build a completely open blockchain technology, which allows anyone and everyone to join and contribute to the network. Anyone can join and participate in the blockchain network's essential operations in a public blockchain technology. The ongoing operations on the public blockchain technology can be read, written, and audited by anybody, which helps a public blockchain technology preserve its self-governed nature. The public blockchain technology network is operated on an incentive system that encourages new users to join and keeps the network flexible. From the standpoint of a truly decentralized, democratized, and authority-free functioning, public blockchains technology are a particularly valuable answer.

One of the most common varieties of Blockchain technology is public blockchain, which is both open and decentralized. Furthermore, in this particular application of Blockchain technology, anyone interested in transactions may essentially access computer networks. Additionally, two types of Proof-of-work and Proof-of-stake models are being employed. In this case, validation is dependent on the validated individual receiving the transaction rewards. Additionally, the public blockchain is an open distributed ledger system that doesn't require any form of authorization. Anyone with access can be given permission to access all or a portion of the blockchain's data. Additionally providing authorisation for both the present and historical data.

a. It is a permissionless distributed ledger on which anybody can join and conduct transactions.
   b. It is a non-restrictive form of the ledger in which each peer has a copy. This also means that anyone with an internet connection can access the public Blockchain technology.
   c. This user has access to historical and contemporary records and the ability to perform mining operations.
   d. These complex computations must be performed to verify transactions and add them to the ledger.

On the blockchain technology, no valid record or transaction may be altered. Because the source code is usually open, anybody can check the transactions, uncover problems, and suggest fixes. Salah, Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Advantages of Public Blockchain Technology

1. **Trustable:** Public Blockchain nodes do not need to know or trust each other because the proof-of-work procedure ensures no fraudulent transactions.
2. **Secure:** A public network can have as many participants or nodes as it wants, making it a secure network. The higher the network's size, the more records are distributed, and the more difficult it is for hackers to hack the entire network.

3. **Open and Transparent:** The data on a public blockchain technology is transparent to all member nodes. Every authorized node has a copy of the blockchain records or digital ledger. Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Uses of Public Blockchain Technology

1. **Voting:** Governments can use a public blockchain to vote, ensuring openness and trust.
2. **Fundraising:** Businesses or initiatives can use the public Blockchain to improve transparency and trust.
3. **Documentation:** Institutions (universities) can use store students records, books, publications and articles. Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Consortium (Hydrid) Blockchain Technology

The second type of blockchain technology is a consortium, which ensures the protection of the autonomy of a distributed network while limiting the intrusiveness of a single controlling entity. A consortium is a semi-private organization that functions under the direction of a leadership group. Because it functions with governance comparable to present accreditation institutions, a consortium blockchain technology is well suited for higher education. The validation of transactions on the consortium blockchain cannot be done by anyone. Furthermore, only a few of the most important members have the authority to validate transactions. Other members can still validate their transactions before validation is implemented; these relevant members should have access to the agreement. Also known as hybrid, these blockchains technology are public only to a privileged group. The consensus process is controlled by known, privileged servers using a set of rules agreed to by all parties. Copies of the blockchain technology are only distributed among entitled participants; the network is therefore only partly decentralized. Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Consortium blockchains technology is the third kind of blockchains technology. Consortium blockchains technology allow for a hybrid of public and private blockchains, as well as a broad range of customisation options. These include allowing everyone to join the consortium network after proper identification verification and issuing select and targeted permissions to undertake just particular network operations. These blockchains technology are designed to give each member unique permissions. This allows users to conduct certain operations on the blockchain technology, such as read, access, and write data. Consortium blockchain networks are becoming more popular among businesses because they allow them to selectively put limits while configuring the networks and govern the activity of the many users in the required roles.

Although hybrid blockchain technology is not open and interacts with both controlled and decentralized systems, it possesses the qualities of security, integrity, and transparency. As shown, it differs from conventional blockchains in a number of ways. Maximum customizability with both a private permission-based system and a public permission-less system are viewed as the major benefits of hybrid blockchains. Users of these blockchain technology systems can access some areas, while the remainder can be preserved or kept secure thanks to the advantages of the ledger's records. Hybrid blockchains are adaptable enough for users to readily join as a private blockchain technology. This kind of blockchain has the ability to increase the network's security and transparency. Salah, Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Advantages of Consortium/Hybrid Blockchain Technology

1. Secure: A consortium blockchain is more secure, scalable, and efficient than a public blockchain network. It, like private and mixed blockchains, has access controls.
2. Secure: Hybrid Blockchain operates within a closed environment.

Cost-Effective: It also safeguards privacy while allowing third-party contact. Transactions are inexpensive and quick and scale better than a public blockchain network. Salah, Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Uses of Hybrid Blockchain

1. **Real Estate:** Real-estate companies can use hybrid networks to run their systems and offer information to the public.
2. **Highly Regulated Markets:** Hybrid blockchains are also well-suited to highly regulated areas like the banking sector.
3. **Banking and Payments:** A consortium can be formed by a group of banks working together. They have control over which nodes will validate transactions.
4. **Research:** A consortium blockchain can be employed to share research data and outcomes. Salah, Omar, Jayaraman, Yaqoob, & Ellahham (2021).

Private Blockchain Technology

A private blockchain technology is similar to the standard network in that it is owned by a firm and users are invited to join. A private blockchain technology difficulty is that it invites the middleman back into the transaction. Furthermore, centralized configuration methods are ensured in the event of private blockchain technology. Furthermore, only a single body is authorized to make decisions, as well as the authoritativeness of acts and control of the transaction validation process. Private blockchains technology (also referred as permissioned blockchains) use privileges to restrict who can view and write to the blockchain. Because a single entity owns and controls block creation, consensus techniques and mining are frequently unnecessary. A private blockchain technology implementation can be used to run a private blockchain network that enables only selected entry of verified parties, such as for a private business. Only an official and validated invitation permits a participant to join such a private network. Validation is also required, either by the network operators or through the network's implementation of a clearly specified set protocol.

Jirgensons & Kapenieks (2018) asserts that private blockchains are closed systems with access restrictions. The blockchain permits transactions with the system administrator's support. Private blockchain solutions develop these platforms having the features of the following:

1. Full of privacy
2. High efficiency
3. Faster transaction
4. Better scalability
5. Faster and speediness. Jirgensons & Kapenieks (2018)

This type of blockchain technology is works on closed systems and networks only and these are usually useful in the organizations, (universities), enterprises from which only selected members can be joined, this type of blockchain technology contains proper security, authorizations, permissions as well as accessibility.

Advantages of Private Blockchain Technology

1. **Speed:** Private Blockchain technology transactions are faster. This is because a private network has a smaller number of nodes, which shortens the time it takes to verify a transaction.
2. **Scalability:** You can tailor the size of your private Blockchain technology to meet your specific requirements. This makes private blockchains particularly scalable since they allow companies to easily raise or decrease their network size.

Uses of Private Blockchain

1. **Supply Chain Management:** A private blockchain technology can be used to manage a company's supply chain.
2. **Asset Ownership:** A private blockchain technology can be used to track and verify assets (such as patent right copy right etc).
3. **Internal Voting:** Internal voting is also possible with a private blockchain technology.

Therefore, Blockchain technology utilizations are gradually increasing in diverse sectors like Financial Services, Education and Training, Healthcare, Government and Administration, Travel and Hospitality and Retail.

The internet was designed to link individuals with information, which is one difference between blockchain technology and the internet in general. The internet was designed to move and keep knowledge, not necessarily data. To be clear, a copy of the file is delivered whenever someone uploads a document online. A PowerPoint presentation can be sent via an email, but the original presentation's data still belongs to the sender. The file is only delivered in copy form. The presentation can be printed, but the author will still be in control of the original file. A blockchain technology, however, transfers the data itself. The idea behind a blockchain technology is that nothing of value can be copied. The original document is therefore transmitted whenever a file is exchanged on a blockchain technology. The ability to record transactions in a form that cannot be changed, deleted, or compromised is a second tenet of a blockchain technology. Since data on a blockchain technology may only be changed consecutively, a permanent historical record is maintained. As a result, a blockchain technology is comparable to a database that is constantly updated but never overwritten.

Blockchain technology makes it simple to track publications and citations for intellectual property. Blockchain technology is used by Bernstein Technologies to enable organizations and businesses to build a digital paper trail of documents and intellectual property that serves as ownership and existence evidence. Filippova & Voshmgir (2018) contend that the peer review and publication procedure for scholarly work is constrained by the archaic pre-internet age. Academic conferences are the sole venues for presenting research in defense, and academic journals are the only places to publish. The present standard is decried for its sluggishness, repeatability, and vulnerability to fraud, data reporting errors, and plagiarism. By combining the three pillars of academic research—collaboration, financing, and publishing—Blockchain technology, as stated by Filippova & Voshmgir (2018), may give rise to a brand-new platform for scholarly endeavors. Blockchain technology promises tamper-proof outcomes, speed, an open and collaborative communication method, and intellectual property ownership.

The use of tokenized incentives can recognize the accomplishments of various researchers using blockchain technology. According to the authors, an equitable financing system would provide the possibility for every scientist, regardless of career position, to get enough support for their research. The framework for exchanging material without the creator losing ownership is provided by blockchain technology. The sharing of educational materials by professors and their students allows for the interchange of content. The use of course materials developed by instructional designers by adjunct professors can be advantageous without compromising the author's control over the original content. When professors from different disciplines work together to design lessons, development of content can be encouraged.

A worldwide network of academics, students, and corporate resources may foster collaborative learning through institutions. For scientific publication, a number of blockchain businesses have developed. An organization that funds scholarly study of blockchain technology is Scienceroots. For funding research and rewarding peer review, Scienceroot Journal provides tokenized cash. There is an immutable archive for each article. Pluto publishers removes obstacles in academia by enabling open academic communication on a blockchain technology where no one person or organization is in charge of the system. Public blockchain technology are used to store articles, and scholars are paid by having their academic reputations protected. Decentralized research platform such as DEIP Publishers is supported by token issuance. Science funds are awarded based on consensus by the engaged community, according to a database maintained by DEIP Publishers. Materials zone, a database business, has acquired a million dollars in investment to create a community-driven platform that would let researchers exchange and market their data. Building an open science economy is MaterialsZone (is a blockchain technology storage system) main goal. The goal of MaterialsZone is to publish scientific publications that include all the research data often omitted from articles with the ability to replicate outcome and present facts and figures that can be trusted anywhere. Filippova & Voshmgir (2018).

The Utilization of Blockchain technology in Academic Research Activities

Blockchain technology, at its core, is a decentralized and immutable ledger that records transactions in a transparent and secure manner. This technology has the potential to address some of the key challenges faced by researchers and institutions in the academic community. One such challenge is the issue of data integrity and reproducibility. With blockchain technology, research data can be securely stored and verified, ensuring its authenticity and preventing any tampering or manipulation. This would enhance the credibility and trustworthiness of research findings, ultimately leading to a more robust and reliable body of knowledge. Ismail & Sidek. (2019).

Filippova & Voshmgir (2018) stated that academic research emerges as a guiding light, leading the way towards the frontiers of knowledge. However, this noble venture is not without hurdles chief among them are ensuring the authenticity of data, safeguarding its security, and effectively sharing scholarly works. Blockchain technology, initially conceived as the foundational technology for cryptocurrency, has evolved into a decentralized, transparent, and immutable ledger system, showcasing its capabilities beyond financial applications. Its inherent features of decentralization, security, traceability, and consensus mechanisms position blockchain as a promising solution for revolutionizing various sectors.

Damian & Manea (2019) maintained that the fusion of academic research and blockchain reveals itself in numerous dimensions safeguarding the integrity of research data, combating plagiarism, ensuring transparent authorship, and expanding collaborative research horizons.

Kim, (2021) averred that Blockchain technology can make a profound impact is in the realm of intellectual property rights. Plagiarism and copyright infringement are persistent problems in academia, and blockchain technology can provide a solution by creating a decentralized system for copyright registration and verification. By timestamping and encrypting research work on the blockchain, authors can establish ownership and protect their intellectual property rights, while also facilitating collaboration and knowledge sharing

Lam & Dongol (2020) opined that blockchain technology can streamline the process of peer review and academic publishing. The current system is often plagued by delays, biases, and lack of transparency. By leveraging blockchain, the peer review process can be made more efficient, transparent, and accountable. Smart contracts can be used to automate the review process, ensuring that it is fair and unbiased. Additionally, blockchain-based platforms can enable open access publishing, making research findings more accessible to the wider academic community. The utilization of blockchain in research academia holds immense potential for transforming the way knowledge is created, shared, and validated. By addressing issues of data integrity, intellectual property rights, and peer review, blockchain can enhance the quality and reliability of academic research. Selwyn (2018).

The bedrock of modern and scientific research lies in transparency, a fundamental tenet ensuring the verifiability and replicability of experimental results, constituting the essence of the scientific method. However, recent times have witnessed mounting concerns regarding the ability to reproduce and have confidence in research findings. Instances of scientific impropriety, data manipulation, and publication bias have cast doubt upon the trustworthiness of research outcomes. Blockchain technology emerges as a transformative force, characterized by its decentralized and incorruptible nature. It stands poised to effectively address these apprehensions. By meticulously recording every transaction and alteration on an immutable ledger, blockchain offers an auditable and transparent trail of research endeavors. This pivotal feature profoundly elevates the credibility and faith in research outcomes. Any attempts at modification or tampering are promptly discernible, ensuring the sanctity and integrity of the scientific process. Jirgensons & Kapenieks (2018).

Moreover, the digital epoch has ushered in novel challenges concerning data security and the preservation of intellectual property rights. Research outcomes, datasets, and intellectual property embody invaluable assets necessitating robust protective measures. Krdzalic (2021).

Concept of Commercialization

Commercialization is the process of transition from research to the actions required for new innovative technologies, processes, and products to achieve market entry and general market competitiveness. It also refers to the services that help, support, equip, finance, or otherwise support a person, an entity and ideas with that transition. all actions taken to make, use, import, sell, and offer for sale a product after regulatory approval has been obtained. These actions also include post-approval, post-launch marketing, promoting, detailing, marketing research, distributing, customer service, managing, and commercially selling the product, as well as any importing, exporting, or transporting. Any activity relating to a Licensed Product's commercialization in the Field or the Territory is referred to as commercializing and includes pre-launch and launch activities, pricing and reimbursement activities, marketing, manufacturing for commercial sale, promoting, detailing, distributing, offering for sale, and selling the Licensed Product. Commercialization refers to activities that are specifically related to the pre-launch, launch, promotion, marketing, sales force recruitment, pricing determination, sale and distribution of a product and post-launch activities, such as: (a) manufacturing and distribution for commercial sale, (b) strategic marketing, (c) medical education and liaison, (d) all customer support and (e) product development.

Introducing new goods or services to the market is a process known as commercialization. Production, distribution, marketing, sales, customer support, and other crucial activities are all included in the wider act of commercialization, which is essential to the commercial success of the new good or service.

Commercializing research findings is at the core of the continuous technological process. This may be defined as the process of transforming an idea into a something or service that can be purchased on the market and earn money for the institution. Continuous commercialization fosters the technological development process, which is essential for long-term economic success. In many developing market economies, encouraging the commercialization of research outputs has taken on particular significance. Due to this, it is now necessary for all parties involved in the technological process, including manufacturers and research institutions, as well as regulatory bodies, to connect and work together in order to advance innovation and commercialization.

Due to the increasing knowledge-intensive nature of economic activity worldwide, high technology businesses are growing, and there is a rising need for highly qualified workers. Increased investment in knowledge-related fields like research and development, education, and innovation—all crucial to economic growth—has become necessary as a result of this. Association for International Development (OECD, 2021). Research is a method of displaying one's competence and aptitude in addressing an issue, and it is a significant indicator of a country's technical capability. One of the most important functions of research is to foster industry, which creates employment and money, arrests societal ills, and aids in the reduction of rural-urban migration. Hence, commercialization of research findings is becoming an important aspect of economic development. However, while commercialization has led to substantial investments in public research in America, the perception in Europe is that the continent has failed to benefit from its substantial investments in public research. European governments have responded by introducing policies to promote commercialization such as introduction of university courses on entrepreneurship for future academics and a range of other programmes to encourage technology transfer by promoting formal contractual relationships between the business sector and public science (Appiah, , Agyapong & Asamoah (2021) In India, the development and commercialization of new technologies have become very important in the research agenda. Even though India started development of its scientific infrastructure in a planned way immediately after independence, commercialization of technology attracted the attention of policy makers in early 1980's. Kumar & Jain (2018) venture capital funds was established earlier and a technology policy statement was also introduced to provide risk-sharing funds as well as managerial expertise for technology development and commercialization.

Rapid technical innovation, strong knowledge management strategies, and a clear emphasis on industries, commodities, and services with added value are all necessary for the successful commercialization of research findings in any country. The globe confronts significant problems including climate change,

dwindling natural resources, and shifting age demographics. Bently (2018) As a result, the need to shift to a more sustainable economy is opening up opportunities on the global market for completely new solutions. The global economic system has undergone a profound change as a result of technological advancement. The countries and companies who can perform at greater levels in terms of innovation will be in a good position to take the lead in the future. As a result, the only tangible indicator of wealth is no longer used. It must be evaluated in terms of the extent of availability and prompt use of information and technology that results in highly valuable new capabilities. As most industrialized nations embrace technology as a significant driver of economic policy, commercialization of research outcomes has emerged as the new catchphrase.

Theoretical Framework

Diffusion of Information (DOI) Theory

Diffusion of Information (DOI) Theory, this theory seeks to explain how, why, and at what rate new ideas and technology spread through cultures. This theory was developed and popularized by F.M. Rogers (1962) in his book, Diffusion of Innovations. He opines that diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system or specific population. Rogers explained the process of innovation diffusion as one which is dictated by uncertainty reduction behaviour amongst potential adopters during the introduction of technological innovations. Innovation Diffusion Theory (IDT) consists of six major components: innovation, characteristics, individual user characteristics, adopter distribution over time, diffusion networks, innovativeness and adopter categories, and the individual adoption process. Arguably, the most popular of the six components of IDT centers on the characteristics of the innovation itself. After analyzing a variety of previous innovation diffusion studies, Rogers singled out the five characteristics of innovations that consistently influence the adoption of new technologies.

The theory focuses on the fact that new ideas (innovations) or technologies, are being created continually and that communication becomes vital in spreading or disseminating the innovation to society or communities. This is primarily because acceptance of the innovation or technology will depend on the individual's attitude towards that innovation. Also, communities have a choice in rejecting or accepting the innovation. Diffusion of Information (DOI) is a theory that strives to explain how, why and at what rate new ideas and technologies are transmitted or spread through cultures. Thus different approaches and theories, such as Diffusion of Information (DOI), have been employed by some organisations to address this challenge, as well as to guide decision making in the diffusion of strategic plans. Diffusion of Information (DOI) consists of various characteristics of innovation, including relative advantage, compatibility, complexity, trialability and observability, enabling the theory to guide and facilitate decision making during innovation and diffusion of the innovations within environments. The innovation-decision process of Diffusion of Information (DOI) comprises five stages: knowledge, persuasion, decision, implementation and confirmation. It is through this process that the innovation is communicated to the society or community. Depending on the individual's attitude they may either accept or reject the innovation. Therefore it is through the characteristics that potential adopters are able to evaluate the innovation. As mentioned earlier, DOI is a sociology theory but it may be used in other fields. Diffusion of Information (DOI) has been used by practitioners in both industry and academia. This could be attributed to the fact that the theory focuses on Diffusion of Innovation through certain communication channels over time within a particular social system.

The innovation of diffusion theory provides a foundation that can be used to guide and understand the factors that influence innovation diffusion within a social system, including organisational strategy. Due to the criticality of people's roles, application of Diffusion of Information (DOI) to understand and analyse Information Technology innovation implementation challenges in Information Technology supply chain. This strength forms the basis for understanding the adoption of technology such as Information Technology for organisational strategy enablement and support. The usefulness of the theory, is that it is adaptable and flexible and it can fit a formal and informal environment during adoption.

Technology innovation can create uncertainty in the minds of potential adopters and the environment at large.

METHODOLOGY

The design for the study was descriptive survey. The population of the study comprised all the 2815 lecturers of the University of Port-Harcourt, Rivers State University, Port Harcourt and Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt. This consisted of 1450 from the University of Port Harcourt, 960 from the Rivers State University, Port Harcourt and 405 from the Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt. The sample size for the were determined using Taro Yamane formular which gave four hundred and eleven (411) comprising lectures in public universities in Rivers State which represent 10% of the population (2815) lectures in the University of Port Harcourt, Rivers State University, Port Harcourt. Ignatius Ajuru University, Rumuolumeni, Port Harcourt. This served as respondents for the study. Stratified random samplings technique was used for the selection of the sample. The instrument that was be used for data collection was be self-designed questionnaire titled: Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities Questionnaire (IIPCMBTPUQ). The questionnaire was divided into two sections: A & B. Section A contained the demographic data of the respondents while section B comprised the questionnaire variables. The questionnaire was structured along the point modified likert rating scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). In scoring the questionnaire, the weighted points was added up as 4+3+2+1= 10 divided by 4 which yielded 2.5 as the criterion mean. Therefore, any item below 2.5 was disagreed on while those above the criterion mean of 2.5 will be accepted In order to determine the validity of the instrument, copies of the questionnaire were given to the researcher's supervisors, three expert in Educational Management and experts in Test and Measurement in Faculty of Education, University of Port Harcourt, to ascertain the face and content validities of the instrument. The researcher conducted a pilot study in order to ascertain the reliability of the instrument. These were done by administering 20 copies of the instrument to 20 lecturers who will not participated in the study. Cronbach Alpha method was used to test the internal consistency of the instrument Innovating Intellectual Property Commercialization Models through Blockchain Technology in Public Universities Questionnaire (IIPCMBTPUQ). Each of the clusters obtained the following reliability index coeffiecient; Blockchain Utilization (0.70), Commercialization Strategies (0.83), respectively. An overall reliability index coefficient of (0.87) was obtained.The one hundred and eleven (111) copies of the questionnaire was administered to the respondents in their respective universities by the researcher and two trained research assistants was on ground to answer the questions that the respondents posed. The researcher and the assistants distributed the questionnaire to the respondents to be filled immediately while waiting for the completion of the filling of the questionnaire. At the end, the questionnaire was collected on the spot to avoid any loss of copies. Mean, standard, deviation and rank order will be used to answer the research questions while z-test were used to test the hypotheses at 0.05 level of significance. Table was constructed for all the research questions and hypotheses.

RESULTS AND DISCUSSION

Variables of the study can be used to draw the logical conclusion for study.

Answer to Research Questions

Research Question One: *How can blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State?*

Table 4.1: Mean $(\overline{X})$ and Standard Deviation (SD) on the Responses of Male and Female Lecturers on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State

S/No	Items Blockchain Utilization Variables	Male Lecturer $\overline{x}$	SD	Female Lecturer $\overline{x}$	SD	Weighted Mean	Remark
1	The use of blockchain technology in academic research can enhance data security and prevent unauthorized access to research findings	3.17	0.72	2.86	0.79	3.02	Agreed
2	Blockchain technology can enhance the credibility and reliability of academic citations and references, mitigating issues of plagiarism and academic misconduct.	3.13	0.69	2.76	0.82	2.95	Agreed
3	Blockchain technology can enable the creation of decentralized academic publishing platforms, empowering researchers to have greater control over their own publications.	3.13	0.76	2.87	0.65	3.00	Agreed
4	implementation of blockchain technology in academic research can foster greater trust and collaboration between universities, researchers, and funding bodies	3.23	0.65	2.99	0.69	3.11	Agreed
5	Blockchain technology may face resistance from traditional academic institutions and stakeholders who are hesitant to adopt new technological solutions.	1.87	0.62	1.85	0.50	1.86	Disagreed
6	Blockchain technology can provide a secure and immutable record of researchers' contributions, enabling fair recognition and attribution in academics.	3.18	0.75	3.01	0.72	3.10	Agreed
	Average	**2.95**	**0.70**	**2.72**	**0.83**	**2.84**	

Data on Table 4.1 shows that most of the items had weighted mean scores above the criterion mean of 2.50 and were seen to a high degree on how blockchain technology can be effectively utilized to revolutionize academic research in universities in Rivers State. In summary, with an aggregate weighted mean of 2.84 which is above the criterion mean of 2.50, the respondents agreed that the use of blockchain technology in academic research can enhance data security and prevent unauthorized access to research findings; enhance the credibility and reliability of academic citations and references, mitigating issues of plagiarism and academic misconduct; enable the creation of decentralized academic publishing platforms, empowering researchers to have greater control over their own publications; can foster greater trust and collaboration between universities, researchers, and funding bodies; can provide a secure and immutable record of researchers' contributions, enabling fair recognition and attribution in academics.

Research Question Two: *What are the commercialization strategies utilized in Universities in Rivers State?*

Table 4.2: Mean $(\overline{X})$ and Standard Deviation (SD) on the Responses of Male and Female Lecturers on the commercialization strategies utilized in Universities in Rivers State

S/No	Items Commercialization Strategies Variables	Male Lecturer $\overline{x}$	SD	Female Lecturer $\overline{x}$	SD	Weighted Mean	Remark
1	University actively promotes and markets its research capabilities and expertise to attract industry partnerships.	3.06	0.74	2.91	0.85	2.99	Agreed
2	University offers training programs and workshops to educate researchers on the commercialization process.	2.96	0.80	3.03	0.74	3.00	Agreed
3	University provides adequate support and resources for faculty members to pursue commercialization activities.	3.01	0.81	3.21	0.74	3.11	Agreed
4	University has implemented partnerships with industry for research collaborations and commercialization opportunities.	3.12	0.84	2.99	0.79	3.06	Agreed
5	University actively promotes and encourages entrepreneurship among its students and faculty members.	1.86	0.54	1.94	0.54	1.90	Disagreed
6	University has established technology transfer offices to facilitate the commercialization of research findings.	3.10	0.87	2.78	0.90	2.94	Agreed
	Average	**2.84**	**0.77**	**2.81**	**0.76**	**2.83**	

Data on Table 4.2 shows that most of the items had weighted mean scores above the criterion mean of 2.50 and were seen to a high degree the commercialization strategies utilized in Universities in Rivers State. In summary, with an aggregate weighted mean of 2.83 which is above the criterion mean of 2.50,

the respondents agreed that university actively promotes and markets its research capabilities and expertise to attract industry partnerships; offers training programs and workshops to educate researchers on the commercialization process; provides adequate support and resources for faculty members to pursue commercialization activities; has implemented partnerships with industry for research collaborations and commercialization opportunities; has established technology transfer offices to facilitate the commercialization of research findings.

Hypotheses Testing

HO_1: There is no significant difference between the mean scores of male academic staff and female academic staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State.

Table 4.7: t-test Analysis on the difference of Male and Female Academic Staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State

Academic Staff	N	$\overline{X}$	SD	Level of sig	Df	t-cal	t-critical	Decision
Male	240	2.95	0.70					Significant (Reject Ho_1)
				0.05	409	3.04	1.96	
Female	171	2.72	0.83					

Data on the Table revealed the summaries of Subject, mean, standard deviation and t-test of difference between the mean scores of Male and Female Academic Staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State. The calculated t-test value used in testing hypothesis stood at 3.04, while t-critical value stood at 1.96 using 409 degree of freedom at 0.05 level of significance.

At 0.05 level of significance and 409 degrees of freedom, the calculated t-value of 3.04 is greater than the t-critical value of 1.96. Hence there is a significant difference between the responses of the respondents. Consequently, the researcher rejected the null hypothesis, and concluded that there is a significant difference between the mean scores of male academic staff and female academic staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State.

HO_2: There is no significant difference between the mean scores of male academic staff and female academic staff on how commercialization strategies utilized in Universities in Rivers State.

Table 4.8: t-test Analysis on the difference of Male and Female Academic Staff on how commercialization strategies utilized in Universities in Rivers State

Academic Staff	N	$\overline{X}$	SD	Level of sig	Df	t-cal	t-critical	Decision
Male	240	2.84	0.77	0.05	409	0.391	1.96	Not Significant (Accept Ho_2)
Female	171	2.81	0.76					

Data on the Table revealed the summaries of Subject, mean, standard deviation and t-test of difference between the mean scores of Male and Female Academic Staff on how commercialization strategies utilized in Universities in Rivers State. The calculated t-test value used in testing hypothesis stood at 0.391, while t-critical value stood at 1.96 using 409 degree of freedom at 0.05 level of significance.

At 0.05 level of significance and 409 degrees of freedom, the calculated t-value of 0.391 is less than the t-critical value of 1.96. Hence there is no significant difference between the responses of the respondents. Consequently, the researcher failed to reject the null hypothesis, and concluded that there is no significant difference between the mean scores of male academic staff and female academic staff on how commercialization strategies utilized in Universities in Rivers State.

DISCUSSION OF FINDINGS

Effective Utilization Blockchain Technology in Revolutionizing Academic Research

The findings of the study showed that the use of blockchain technology in academic research can enhance data security and prevent unauthorized access to research findings; enhance the credibility and reliability of academic citations and references, mitigating issues of plagiarism and academic misconduct; enable the creation of decentralized academic publishing platforms, empowering researchers to have greater control over their own publications; can foster greater trust and collaboration between universities, researchers, and funding bodies; can provide a secure and immutable record of researchers' contributions, enabling fair recognition and attribution in academics. This finding is in agreement with Kim, (2021) averred that Blockchain technology can make a profound impact is in the realm of intellectual property rights. Plagiarism and copyright infringement are persistent problems in academia, and blockchain technology can provide a solution by creating a decentralized system for copyright registration and verification. By timestamping and encrypting research work on the blockchain, authors can establish ownership and protect their intellectual property rights, while also facilitating collaboration and knowledge sharing. Hence, the utilization of blockchain in research academia holds immense potential for transforming the way knowledge is created, shared, and validated. By addressing issues of data integrity, intellectual property rights, and peer review, blockchain can enhance the quality and reliability of academic research. Selwyn (2018). Moreover, the digital epoch has ushered in novel challenges concerning data security and the preservation of intellectual property rights. Research outcomes, datasets, and intellectual property embody invaluable assets necessitating robust protective measures. Krdzalic (2021).

The study indicates that There is a significant difference between the mean scores of male academic staff and female academic staff on how blockchain technology be effectively utilized to revolutionize academic research in universities in Rivers State.

CONCLUSION

Based on the findings of the study it is concluded that the integration of blockchain technology in intellectual property commercialization models within public universities holds significant promise for enhancing transparency, security, and efficiency in the management and monetization of intellectual assets. By leveraging blockchain's immutable and decentralized nature, universities can streamline processes, reduce administrative burdens, and foster greater collaboration with industry partners. However, challenges such as regulatory compliance, and data privacy must be carefully addressed to realize the full potential of blockchain. Overall, the adoption of blockchain technology in intellectual property management represents a transformative opportunity for public universities to unlock new revenue streams, protect intellectual assets, and drive innovation.

RECOMMENDATIONS

Based on the findings and conclusion of the study, the following recommendations were made:

1. Conduct a comprehensive feasibility study to assess the readiness and potential benefits of implementing blockchain technology in the intellectual property commercialization process within public universities.
2. Collaborate with industry experts, legal professionals, and technology specialists to develop robust smart contracts that automate licensing agreements, royalty payments, and intellectual property transactions on the blockchain.
3. Establish secure data governance frameworks and protocols to ensure compliance with data protection regulations and safeguard sensitive intellectual property information stored on the blockchain.
4. Invest in staff training and capacity-building initiatives to equip university personnel with the necessary skills and knowledge to effectively utilize blockchain technology in intellectual property management.

5. Foster partnerships with blockchain development firms and research institutions to stay abreast of the latest technological advancements and best practices in blockchain implementation for intellectual property commercialization.

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