STUDY OF FACTORS INFLUENCING THE USE OF BLOCKCHAIN TECHNOLOGY IN STUDENT INFORMATION SYSTEM AT UNIVERSITIES

A THESIS

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BY

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ABSTRACT

The rapid advancement of technology has allowed for the development of novel approaches to improve the way student information systems are maintained in every institute/university. The field of education is undergoing a transformation into the current era. Indeed, technology and education are a great fit that has been increasingly popular in recent years. As a result, educational technology has grown in popularity around the world. We cannot, however, address the usage of technologies without also tackling the question of security. Every university has a crucial data of students that needs to be protected. The most essential documents given to students by universities are their educational certificates. Because the issuance procedure is not transparent and verifiable, it is simple to create fake certificates. A well-crafted fake certificate might be difficult to recognize and be fooled for the genuine article. Currently, most universities use a centralized method of data storage, which increases the risk of data tampering. Failure to follow proper security standards will result in additional financial and human resource expenditures.

Researchers and practitioners have presented a number of recommendations, techniques, and strategies to aid in the decision-making process about the security measures that should be taken following the early use of technology in education. With the rise of digitization, it is becoming increasingly vital for universities to accept technological change in order to maintain a stronger Student Information System. Blockchain is one such technology model.

Blockchain can be viewed as a broad term that encompasses a wide range of technology and uses. Blockchain is a decentralized ledger that allows all peer-to-peer transactions to be recorded without the need for a centralized authority. The blockchain concept is akin to the Internet, which contains a diverse set of underlying technology and uses. Transacting in a trustless environment is possible because of blockchain technology. A digital ledger of all transactions across a specific network is verifiable by any computer

on that network using the distributed database system, avoiding the need for a central authority.

With evolution of many technologies and adoption of models, block chain is receiving a positive acceptance by many domains such as finance, logistics, health care, supply chain, agriculture, and education sector as well. Studies have proved that using blockchain has improvised the work culture and turnover of organizations. It is also found that few domains and organizations hesitate to adopt and diffuse the block chain technology. Various adoption theories have been implemented to analyze the reasons of adoption of block chain in all domains. In India it is found that very less focus is given to exposure of new technologies and its implementation with context to education sector. With context to education industry, this research contributes in understanding the factors that influence the adoption of new technology or more specific block chain technology.
By proposing an expert conceptual blended interdependence model that will include all relevant factors, an objective analysis of use cases is possible to help guide the decision of embracing blockchain in university information system. The purpose of the research is to identify the individual factors that determine universities intention to use blockchain. In particular two factors namely Use behavior or usage behavior and Intention to use, of universities can be investigated by using a combo model of TAM (Technology Acceptance Model and UTAUT (Unified Theory of Acceptance and Use of Technology) Model. These models are meant to serve as comprehensive models that can be applied across a range of applications.

The conceptual blended interdependence model will direct in the selection of a Blockchain use case. The research methodology adopted is both Qualitative and Quantitative research method. The sampling technique used is simple random sampling technique with a sample size of 345. The statistical tests performed are, correlation analysis to find the interdependence of individual factors of both TAM and UTUAT. The multiple regression analysis, Chi-square tests was used as a statistical tool. The questionnaire was circulated amongst all the universities across western India which includes, Rajasthan, Gujarat, Maharashtra and Goa. The target population was divided into categories following categories; Higher level which had all the top management dignitaries of universities, middle level, which included faculty members and head of departments and lower level which included technical support staff which were involved in managing the university database.

The results of data analysis show that there is highly correlation between he constructs of UTAUT and TAM factors with Usage behavior of universities to adopt the block chain technology. The researcher has identified several demographic factors to see how the respondents belonging to different categories of demography respond to the decision of implementing block chain in their respective universities.

From the results it is observed that for successful implementation of blockchain, universities must have necessary collaborations with other universities and stakeholders covering larger region. It is observed that this necessity is lacking in our Indian universities. It is also observed that, besides the way universities operate, the employees also need to shift paradigms. Currently, IT is designed to exclude others. This design needs to shift to include others, making them participants instead of subordinates, clients, or users. Universities are hesitant to invest in blockchain. Universities might not think the technology has proven itself yet, are risk-averse, have recently invested in new digital infrastructure, or have existing legacy systems delaying the introduction of new technology. It is also observed that many universities do not know what their future market function will be. Because of this, they do not know which use cases will be viable in the long-term. This creates a solution-before problem thinking environment. Solution-before-problem thinking means that universities will try to integrate a blockchain in business processes where it offers little to no practical benefit.

This research study contributes to identifying the factors that are responsible in adoption of blockchain in education sector specifically in relation to university information system. The conceptual model using TAM and UTAUT variables is the core theoretical contribution. This conceptual model has been designed using the variables of two adoption theory models, namely TAM and UTAUT. The proposed blended interdependence model of TAM and UTAUT consists of those factors that influence the use behavior of universities to use the blockchain in university information system.

From this study, it is observed that current university management needs to analyze these factors that could be useful for taking a decision to adopt blockchain in managing the student database in universities. It has also been noted from the study that many universities are unaware about the knowledge and infrastructure required for use of blockchain. This study also presents an opportunity to universities to benefit from the guidelines on how to implement blockchain in managing the university information system. Conclusively, the universities will have a clear understanding of all the features that are responsible for use of blockchain in university information system. The guidelines on how to use the blockchain in UIS will also be helpful in taking a decision on the adoption of blockchain in managing the student information system

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List of Abbreviations

Abbreviation	Explanation
BI	Behavioral Intention
BCMM	Blockchain Maturity Model
BUC	Blockchain Use Criteria
BDN	Blockchain Distribution Network
CUTAUT	Compatibility UTAUT
CPU	Central Processing Unit
CMM	Capability Maturity Model
CFA	Confirmatory Factor Analysis
DNS	Domain Name System
DOI	Diffusion of Innovations Theory
DER	Distributed Energy Resources
DEP	Distributed Energy Prosumers
DSO	Distribution System Operators
D2D	Device-to-Device
ETAM	Extension of TAM
ERP	Enterprise Resource Planning
EVM	Ethereum Virtual Machine
EHR	Electronic wellbeing records
EE	Effort Expectancy
ECC	Elliptic Curve Cryptography
EFA	Exploratory Factor Analysis

Abbreviation	Explanation
FC	Facilitating Conditions
IM	Igbaria's Model
IT	Information Technology
IoT	Internet of Things
IS	Information Systems
ITU	Intention to Use
ICT	Information and Communication Technology
KYC	Know Your Customer
LC	Letter of Credit
LSTM	Long Short Term Memory
MM	Motivational Model
MOU	Memorandum of Understanding
MPCU	The Model of PC Utilization
MAPS	Model of Acceptance with Peer Support
PBC	Perceived Behavioral Control
PC	Personal Computer
PoW	Proof of Work
PoS	Proof of Stake
PEOU	Perceived ease of use
PE	Performance Expectancy
PR	Perceived Risk
PU	Perceived usefulness

Abbreviation	Explanation
PCIT	Perceived Characteristics of Innovating Theory
SN	Subjective Norm
SCT	Social Cognitive Theory
SHA	Secure Hashing Algorithm
SCM	Supply Chain Management
SVM	Support Vector Machine
SES	Sharing Economy Services
SI	Social Influence
SPSS	Statistical Program for Social Sciences
SIoT	Social Internet of things
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behavior
TIB	Theory of Interpersonal Behavior
TAM	Technology Acceptance Model
UTXO	Unexpended Transactions Output
U&G	Uses and Gratification Theory
UAV	Unmanned Aerial Vehicles
UTAUT	Unified Theory of Acceptance and Use of Technology
UIS	University Information System
VSN	Vehicular Social Networks

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Chapter 1

Introduction

The innovation in the technology in recent years has been progressively getting turbulent and metamorphic. The present world has a ceaseless requirement for improved effectiveness. This assertion can be stretched out to pretty much every field and industry like finance, manufacturing, health care and education too. Education Systems is no exemption. There is a need of consolidating most recent innovation to improve their overall coherence. The rapid growth of technology has enabled the invention of novel concepts to enable advancement in how to keep student information safe and secure in every university. Every university contains sensitive student information that must be safeguarded. It has been determined that the current university structure is inefficient because it employs a centralized data storage and management system. Data manipulation therefore cannot be ruled out. With the rise of digitalization, it's more necessary than ever for universities to embrace change in their present technology model for secure student information system administration.

Blockchain technology is an example of such a technological model. Satoshi Nakamoto, proposed the trending technology of blockchain. Blockchain enables the creation of a decentralized ecosystem in which data is not controlled by a third party (Ibrar Ahmed, Shilpi 19, 2018). Every completed transaction is permanently recorded on a public ledger. This Blockchain is expected to revolutionize the way business, industry, and education operate, as well as accelerate the worldwide development of the knowledge-based economy. The attributes of decentralization, immutability, traceability, and service properties are determined by consensus algorithms and cryptographic techniques in blockchain, which is dispersed in nature.

These characteristics have the potential to inspire a slew of new educational applications. In both official and informal learning environments, blockchain may collect and save a complete set of records of all educational activities, including the technique and results. It also keeps track of teachers' teaching practices and results, which can be used as a reference for teacher assessment. As a result, blockchain has a lot of potential for both students and teachers. Every year, university spends millions to recruit students from all over the world to their programs and courses. This cost rises as their strategy to doing so broadens, including the costly and time-consuming task of confirming each student's credentials and ensuring their legitimacy. The cost and duration of this procedure can be drastically lowered by incorporating blockchain into the system. Professors in the system will not be questioned in grading examinations or assigning credits because pre-programmed smart contracts can handle every detail of awarding marks and credits. Before their findings are published and stored on the blockchain, students will have a vote in their evaluation, resulting in a fair formative crediting system. Students can also apply for additional education, internships, and jobs anywhere in the world, regardless of language barriers or distance. Potential employees will also benefit from such a system because they will be able to approach rising talent from all over the world.

1.1 Introduction to Blockchain

As seen in fig 1.1, blockchain is a decentralized ledger that contains records of transactions or digital events that have occurred and are shared among participating parties. Blockchain eliminates the need for a centralized server by utilizing peer-to-peer networking, allowing the blockchain to exist across an entire network of computers. A digital ledger of all transactions across a specific network is verifiable by any computer on that network using the decentralized automation application avoiding the need for a central authority (Supriya Thakur Aras and Vrushali Kulkarni, 2017).

Any of these unique computers on the network, also known as a "node," has access to the whole database as well as a history of transactions dating back to the first block, known as the "genesis block." A blockchain, as the name implies, is a collection of ‘blocks' linked by complicated computational algorithms. In short, a block is made up of the block header, the hash of the previous block header, and the merkle root. Data containing one or more transactions is collected in the data area of the block to produce a new block. This data is copied, hashed, paired with another hash, hashed again, paired again, and hashed once more, resulting in a single hash known as the merkle root. As each new block contains information from the block created before it, the blocks are ‘chained’ together. There is only one way they will fit together computationally on the blockchain.

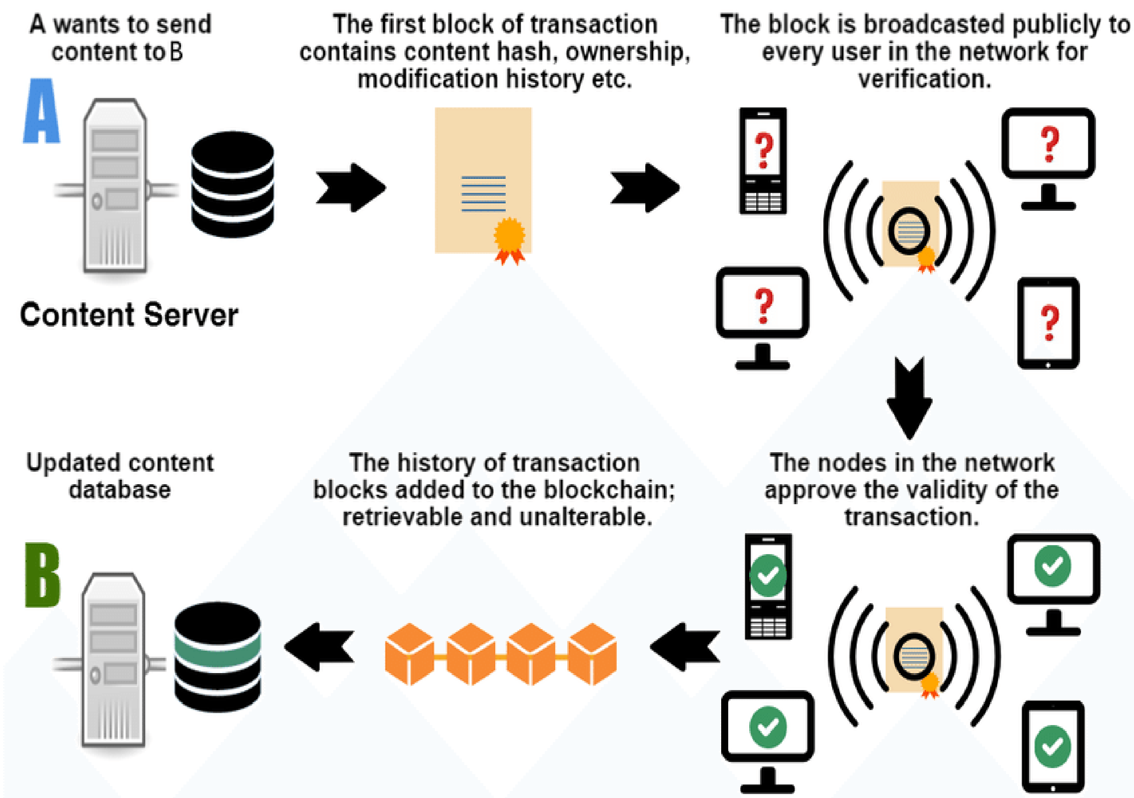


Fig: 1.1 Working of Blockchain

Source: https://www.tutorialandexample.com/working-of-blockchain

Like a traditional public ledger, blockchain might be a series of blocks that carry a whole list of transaction records. Fig 1.2 shows an example of a blockchain structure (Supriya Thakur Aras and Vrushali Kulkarni, 2017, Simon Albrecht and Stefan Reichert, 2018). A block has just one parent block if the block header contains a preceding block hash. It's worth noting that hashes of uncle blocks (children of the block's ancestors) will be retained in the blockchain.

The primary block of a blockchain is named genesis block that has no parent block. A block consists of the block header and the block body as shown in fig 1.3. In particular, the block header includes:

(i) Block version: indicates that set of block validation rules to follow.

(ii) Merkle tree root hash: the hash worth of all the transactions within the block.

(iii) Timestamp: current time as seconds in Greenwich Mean Time since Jan one, 1970.

(iv) nBits: target threshold of a legitimate block hash.

(v) Nonce: associate degree 4-byte field, which sometimes starts with zero and will increase for each hash calculation.

(vi) Parent block hash: A 256-bit hash worth that points to the previous block.

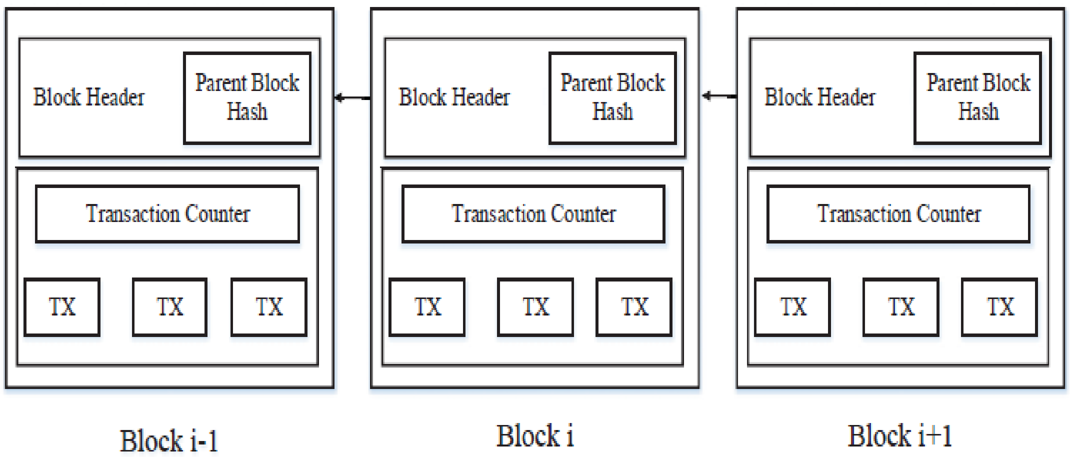


Fig: 1.2 Blockchain architecture

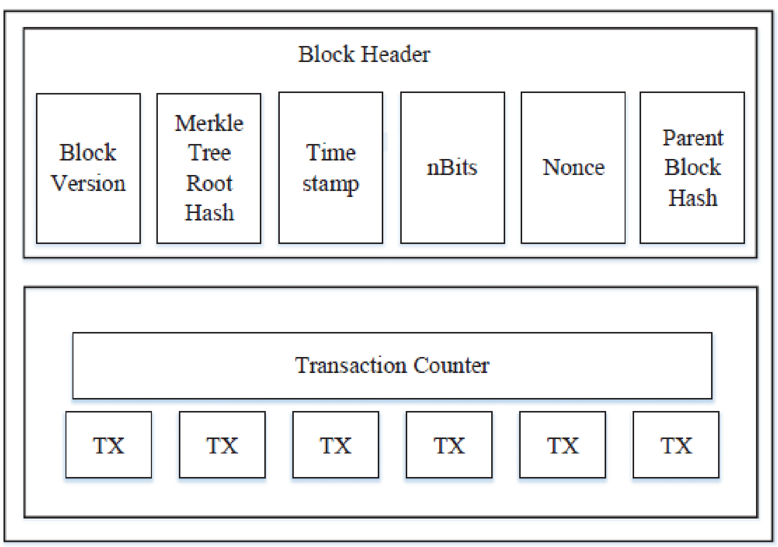


Fig: 1.3 A Blockchain block

Fig: 1.2 and 1.3, Source: https://www.semanticscholar.org/paper/An-Overview-of-Blockchain-Technology%3A-Architecture%2C-Zheng-Xie/ee177faa39b981d6dd21994ac33269f3298e3f68

Basically there are in general four types of blockchain: Permission less blockchain, Permissioned blockchain, Public blockchain and Private blockchain. Blockchain technology is being used in a variety of fields, including financial and non-financial. The technology is no longer viewed as a threat to existing business models by financial organizations and banks. In fact, the world's largest banks are researching creative blockchain applications to see if there are any potential in this sector. Rain Lohmus of Estonia's LHV bank said in a recent interview that they found blockchain to be the most tested and secure for several banking and finance applications. The possibilities for non-financial applications are likewise limitless. The blockchain might be used to verify the existence of all legal documents, health data, and loyalty payments in the music industry, as well as notaries, private securities, and marriage licenses. The anonymity or privacy goal can be achieved by storing the fingerprint of the digital asset rather than the digital asset itself (Daniel Folkinshteyn & Mark Lennon, 2019).

There are a variety of blockchains available to support various applications, including cryptocurrencies. Industry is currently pursuing three techniques to accommodate alternative applications and overcome perceived limits of the Bitcoin blockchain:

Alternative Blockchains: This is a method of achieving distributed consensus on a digital asset using the blockchain algorithm. Merged mining occurs when they share miners with a parent network, such as Bitcoin's. It has been recommended that they incorporate DNS, SSL certification authority, file storage, and voting applications.

Colored Coins: It is an open-source protocol that defines a set of mechanisms for developers to generate digital assets on top of the Bitcoin blockchain by extending its functionality beyond that of digital currency.

Side chains: These are alternate blockchains backed by Bitcoins via Bitcoin contracts, like how dollars and pounds were backed by gold in the past. There might be thousands of sidechains "pegged" to Bitcoin, each with its own traits and objectives, all taking use of the Bitcoin blockchain's scarcity and resilience. Once the experimental sidechains have been tried and tested, the Bitcoin network can iterate to support further functionality.

1.2 Characteristics of blockchain

The blockchain has following key characteristics:

- **Decentralization:** In traditional centralized group action systems, every group action must be validated by a central trustworthy agency (for example, the central bank), resulting in value and thus performance bottlenecks at the central servers. In contrast to the centralized option, blockchain does not require a third party.

- **Persistence:** Transactions are frequently legitimate rapidly, and honest miners would not accept incorrect transactions. Once a transaction has been encapsulated within the blockchain, it is nearly impossible to erase or rollback the transaction. It's possible that blocks containing incorrect transactions will be identified directly.

- **Anonymity:** Each user will interact with the blockchain using a randomly generated address that conceals the user's identity. Due to the inherent constraint of blockchain, proper privacy preservation cannot be guaranteed.

- **Auditability:** The blockchain preserves information on user balances using the UTXO (Unexpended Transactions Output) architecture. Any business dealings must enquire about any past transactions that have not yet been completed. The state of these referred unexpended transactions changes from unexpended to spend once this transaction is recorded into the blockchain. As a result, transactions could be easily confirmed and tracked.

1.3 Drawbacks of centralized database management system

A core unit acts in a way that serves the entire university in a centralized database model. This term is frequently used to represent completely centralized analytics architecture, but it can also refer to a shared information database that is open to everyone. When employing a centralized database, there are severe workload requirements that must be met. Individuals and teams may discover that the time limits imposed on them are insufficient to meet the requirements. A centralized database will eventually generate unresponsive teams that are focused on specialized duties rather than collaboration if these constraints are not addressed as they should be. When you use a centralized database, you're giving up local flexibility in exchange for greater mobility efficiency. If changes occur locally that have an impact on the business, this information must be forwarded to the centralized database. There is no way to regulate the data on a local level. As a result, response times to local consumers or the community may be slower than they may be, as there may be insufficient information to deal with an emergency.

Local managers' responsibilities are frequently decreased when a centralized database is employed. This happens because the company's structure may prevent local managers from hiring their own personnel. It may compel them to use data from a centralized system, which they believe has a negative impact on local operations. Instead of being able to make judgments right away, they must wait for data from the centralized database to arrive. The centralized approach can be depressing for those who want to experience increased degrees of responsibility in their management capacity. There is no need to concentrate on the development of new or incoming managers because the information is kept by a single database. With this system, the only sort of succession planning that is required is bringing in someone to replace a core analyst at some point. If top-level managers have a family, health, or other issue that prevents them from doing their work, there may be no one with the required experience to fill the void, reducing the usefulness of the centralized database. Transparency may be provided by a centralized database. It may result in more communication. Those aren't necessarily favorable outcomes. When anybody can express an opinion or provide feedback on information they have received, they frequently feel obligated to do so (Michael Crosby and Nachiappan, 2015).

Many employees may have a general understanding of regulations or procedures, but they might not have complete information. They squander time producing input that isn't required, which wastes time for everyone who receives it. This can result in decreased productivity and increased irritation over time. There is a reliance on the accuracy of the data being collected when a centralized system is in existence. Even a minor error could have a significant influence on the consolidated database. This could lead to greater expenses for rushed deliveries, inaccurate orders that are identified as correct and unneeded adjustments to the organization's prospective inventory. Mending a mistake made by a decentralized system is usually less expensive than fixing a mistake made by a centralized system. When a centralized database is used, everything is kept in one database. What happens to that data if the database is lost for whatever reason? An organization's access to the database is immediately lost because there are no other database sites. This could result in a long-term outage, jeopardizing the company's overall sustainability. When employing a centralized database, even with cloud backup mechanisms and other safeguards in place, there is always the possibility of total loss.

The benefits and drawbacks of a centralized database must be considered at the local level. The centralized structure makes sense for some firms because it brings people and teams together with a common goal in mind to work toward a common goal. For others, the system may generate an excessive number of data points, slowing overall output. The current student information system in universities necessitates a coordinated effort between organizations and universities. The system is built on a centralized database system that necessitates server data backups. Everyone on the network has access to an updated file, which the database owner can change. By implementing blockchain technology, this can be prevented. Blockchain technology will assist universities in storing data across all networked systems (Grech, Alexander; Camilleri, Anthony F, 2017). Because each machine has its own copy of the data saved in the database, which is known as a decentralized and distributed ledger, a file cannot be easily edited with this kind of data storage. This decentralized and distributed database should have same copy of data.

1.4 Introduction to Theories of Adoption Models

One of the more established areas of IS study is technology adoption. The development of numerous theories and models has resulted from research in this subject, which has progressed throughout time by conceiving new aspects that can better explain the phenomena of technology adoption. This process of evolution has been primarily fueled by the quickly changing technological environment, and it has resulted in the emergence of new factors based on theories from other fields.

Organizations and governments are investing heavily in the introduction of new technologies that have the potential to cause a paradigm shift in the consumers' lifestyles. However, if the improvements are not embraced by the target users, these investments may be in nothing. Several studies have shown that technology adoption is a considerably more complex process involving characteristics of user attitude and personality, social impact, trust, and a variety of facilitating situations. It's also worth noting that user acceptance and confidence are critical for any new technology's development. Furthermore, user involvement in the development of the system has been seen as a factor in acceptance. Acceptance is described as "a concept that is opposed to the term refuse and refers to a positive decision to use an innovation." Decision makers must be aware of the factors that influence users' decisions to use a certain system to account for them throughout the development process.

Several models and frameworks have been developed to explain user adoption of new technologies as shown in fig 1.4. These models introduce factors that can affect the user acceptance such as Technology Acceptance Model, Theory of Planned Behavior and Diffusion of Innovation theory, Theory of Reasoned Action, Model of PC Utilization , Motivational Model , Unified Theory of Acceptance and Use of Technology and Social Cognitive Theory and many studies have used these traditional frameworks to conduct their researches and the rest combined previous models or add new constructs to developed models to carry out their study (Hamed Taherdoost et al, 2017).

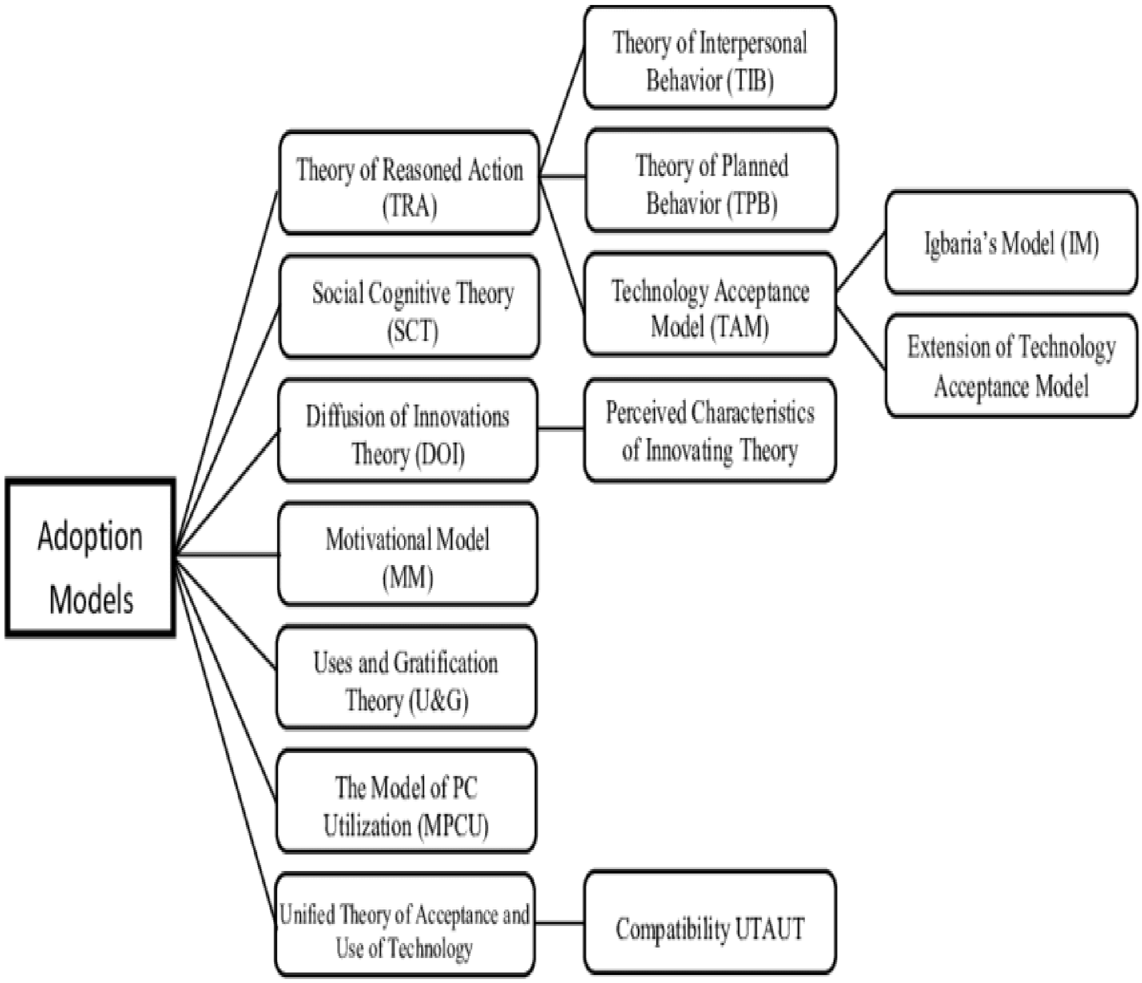


Fig: 1.4 Various adoption models

Source: https://www.researchgate.net/figure/An-overview-of-Adoption-Acceptance-Models

Following are the short descriptions of all the adoption models

i) TRA (Theory of reasoned Action) Model

Any human behavior is predicted and explained in this model by three primary cognitive components: attitudes (a person's favorable or unfavorable feelings toward an activity), social norms (social influence), and intentions (a person's decision to do or not perform a behavior). This type of human activity should be deliberate, methodical, and sensible. In addition, three boundary factors are identified to test and assess the TRA: volitional control, intention stability across time, and measurement of intention in terms of target, time, context, action, and specificity.

Furthermore, several approaches are established to strengthen the robustness between corresponding purpose and attitude, such as generality, target, action, context, and time horizon. The key disadvantages of TRA, on the other hand, are the failure to address the role of habit, cognitive deliberation, misunderstanding through a survey (attitudes, subjective norms, and respondents' intentions), and moral issues. Furthermore, usage voluntariness is a critical issue for TRA validation.

ii) Theory of Planned Behavior (TPB)

To extend the TRA model, perceived behavioral control (PBC) is added as a new variable in this model. PBC is primarily determined by the availability of resources, opportunities, and skills, as well as the perceived importance of those resources, opportunities, and skills in achieving outcomes.

Although both TPB and TRA assumed that a person's behavioral intention (BI) influences an individual's behavior, TPB employs the PBC for actions that are not under the individual's volitional control. By including PBC, not only realistic limitations are created, but also a self-efficacy type factor. Furthermore, PBC has a direct influence on actual behavior as well as an indirect influence via behavioral intentions. As a result, three major factors influence BI in the TPB model: perceived behavioral control, subjective norm, and behavioral attitude. However, there are two major issues with the TPB model. First, if a computer system is inaccessible, one's attitudes toward information technology will be largely irrelevant. Second, the revised TPB may be viewed as a more appropriate theoretical framework that is influenced by the degree of individual voluntariness in deciding whether to use information technology in the workplace.

iii) Theory of Interpersonal Behavior (TIB)

This model primarily clarifies the complexity of human behavior as it is influenced by social and emotional factors. As a result, to improve prediction power, this model includes not only all aspects of TRA and TPB, but also habits, facilitating situations, and affect. Roles, norms, and self-concept are all part of the social factors' notion, which is related to the subjective norms construct in TRA. In summary, an individual in TIB is neither wholly deliberate nor fully automatic, nor fully autonomous nor entirely social.

TRA varies from TIB in that TRA seeks to account for the greatest amount of variance with the fewest variables, whereas TIB seeks to account for the greatest amount of variance overall, because even a tiny amount of variance can be socially significant if the behavior in issue is vital. Emotions, social variables, and habits are highlighted as the major components in forming the intention in this paradigm. To argue the conduct, TIB has three layers. Personal beliefs, attitudes, and social circumstances that influence conduct are influenced at the first level by personal attributes and previous experiences.

The second level illustrates how affect, cognition, and social influences, as well as personal normative views, influence behavior intentions. At the third level, behavioral intentions, situational factors, and prior experience are used to forecast the likelihood of doing a specific activity. In comparison to TRA and TPB, the fundamental disadvantage of TIB is its complexity and lack of parsimony. Furthermore, TIB does not provide a straightforward technique for the operational definition of variables among models, and the researcher is left to do so.

iv) Technology Acceptance Model (TAM)

This model is based on the TRA model. TAM model is eliminated user's subject norms and intriguing due to the TRA model's ambiguous theoretical and psychometric status. Users' motivation is explained by three factors: perceived usefulness, perceived ease of use, and attitude toward use, according to TAM. As a result, TAM would include not just BI, but also two key beliefs: perceived usefulness and simplicity of use, which have a significant impact on the user's attitude. These can be classified as unfavorable and favorable attitudes toward the system. Other elements, termed as external variables, are sometimes considered in the TAM model.

The TAM model is undoubtedly one of the most extensively used in the subject of technology acceptance. It has gained a lot of empirical support throughout the years. TAM is limited in its application outside of the workplace since it ignores the social influence on technology adoption. Furthermore, some external variables must be included to TAM to produce a more consistent prediction of system use. TAM's capacity to apply in a customer situation where the acceptance and usage of information technologies is not only to perform tasks but also to meet emotional needs may be limited because intrinsic motives are not addressed.

v) Extension of TAM (ETAM)

ETAM adds certain new factors to TAM to improve TAM's adaptiveness, explanatory power, and specificity. ETAM is a concept that has been offered in two different research. TAM2 was the first study that looked at the origins of perceived usefulness and BI. To improve the predictive value of perceived usefulness, TAM2 was proposed by adding two categories of factors to TAM: social impact (image, subject norms, and voluntariness) and cognitive (outcome demonstrability, job relevance, and output quality). As a result, TAM2 outperforms in both voluntary and required situations.

The sole exception is in the case of subjective norms, which have an impact in mandated contexts but not in voluntary ones. In the second study, constructs that influence perceived ease of use were discovered. Adjustments and anchors are the two major groups of antecedents that influence perceived ease of usage. General beliefs about the usage of computer systems have been placed in the anchoring group (enjoyment and objective usability), whereas beliefs created based on direct experience with a system have been placed in the adjustments group (external control, computer self-efficacy, computer anxiety, and computer playfulness).

vi) Igbaria's Model (IM)

According to IM, both extrinsic and intrinsic motivators have an impact on the acceptance or rejection of new technologies. Perceived fun was established as an intrinsic motivation, while perceived usefulness was posited as an extrinsic motivator, both of which influenced behavior and attitude in this model. Apart from these elements, perceived usefulness, computer fear, and computer satisfaction all have an impact on user acceptability. Also, both direct and indirect (through satisfaction) influences on adoption are perceived enjoyment and perceived utility. Furthermore, perceived utility has an impact on reported enjoyment and computer anxiety has a detrimental impact on two factors: perceived fun and perceived utility. It has also been proven that computer enjoyment has a direct impact on usage.

vii) Social Cognitive Theory (SCT)

SCT was developed using three key factors: behavior, personality, and environment, all of which interact bi-directionally to predict group and individual behavior. It can also identify techniques for changing and modifying behavior. The behavior component in the SCT model is primarily concerned with issues of usage, performance, and adoption. Personal factors, on the other hand, are any personality, cognitive, or demographic characteristics that define a person. Environmental elements, on the other hand, comprise both physical and social aspects that are physically external to the individual.

SCT is an inseparable triadic structure in which all three components are always influencing and determining one another. The SCT model is used to assess information technology usage by incorporating several factors such as self-efficacy, performance expectations, anxiety, affect, and personal result expectations.

viii) Diffusion of Innovations Theory (DOI)

The DOI model investigates a wide range of innovations by introducing four aspects (time, communication channels, innovation, and social system) that influence the dissemination of a new idea. DOI has been employed not only at the corporate and individual levels, but it also provides a theoretical platform for discussing adoption on a global scale. The DOI model combines three important elements: adopter characteristics, innovation characteristics, and the innovation decision process. The five steps of the innovation decision step, namely confirmation, knowledge, implementation, decision, and persuasion, took place over time through a succession of communication channels among members of a comparable social system. Five key constructions have been identified as effective elements on any innovation acceptance in terms of qualities of an innovation step: relative advantage, compatibility, complexity, trial ability, and observability. Five categories are specified in the adopter characteristics step: early adopters, innovators, laggards, late majority, and early majority. In conclusion, because DOI focuses more on system characteristics, organizational traits, and environmental factors, it has less explanatory power and is less useful for outcome prediction than other adoption models.

ix) Perceived Characteristics of Innovating Theory (PCIT)

Image, voluntariness, and behavior are three additional features identified in this model that are added to the DOI theory. The perception of voluntariness influences conduct, which influences actual behavior when compared to voluntariness. The results reveal that adoption rate and demonstrability are highly correlated, and that as demonstrability rises, so does the adoption rate. Furthermore, observability is made up of two sub-characteristics: visibility and demonstrability of results. In the PCI model, users' willingness to accept or reject an innovation is also influenced by voluntariness.

x) Motivational Model (MM)

The utilization of a system is mostly governed by two factors: intrinsic and extrinsic incentive. Extrinsic motivation is described as the belief that users will want to do something because it is seen to help them achieve valuable outcomes that are unrelated to the activity, such as better job performance. The perception that people will desire to perform an activity for no apparent reinforcement other than the process of executing the activity per se is known as intrinsic motivation. Perceived usefulness is an extrinsic drive, while perceived enjoyment is an inner motivation, according to Davis and Bagozzi. In general, perceived enjoyment and usefulness are influenced by the output quality and perceived simplicity of use. They also included task importance as a mediator of the influence of ease of use and output quality on usefulness. As a result, perceived utility, and enjoyment influence BI indirectly through output quality and perceived ease of use.

xi) Uses and Gratification Theory (U&G)

This model aims to investigate why people are more interested in certain communication mediums than others. The use of media has resulted in specific gratifications. U&G's primary focus is on the social and psychological components of consumers' motivation and satisfaction quests. Motivations, behavioral usage, and satisfaction are the three basic constructs in U&G. Motivation refers to people's overall dispositions that impact their activities to meet their needs. “Patterns of exposure to use (such as volume of use, duration of use, and type of use)” is what behavioral usage refers to. In comparison to other models such as TPB and DOI, U&G is a unique framework that may be used in a variety of media. The U&G model can be employed not only in a media environment for communication, but also in situations where media is used for play and work.

xii) The Model of PC Utilization (MPCU)

Individual acceptability and personal computer (PC) utilization are forecasted using the Model of PC Utilization, which suits the IS approach. They omitted behavior intention from the proposed model because the MPCU model examines actual behavior (personal computer usage). Furthermore, habits are not included in the model since, in the context of PC usage, habits have a tautological relationship with present use. The direct influence of affect, facilitating condition, and long-term repercussions of use, perceived consequences, social influences, complexity, and job fit on behavior is explicitly evaluated by MPCU. The findings show that work fit, social variables, long-term implications, and complexity all have a significant impact on PC usage. The facilitating state and affect, on the other hand, have no effect on PC use. Even though habits are a major predictor of behavior, they are not included in MPCU.

xiii) Compatibility UTAUT (C-UTAUT)

Bouten improved the explanatory power of the UTAUT model by including compatibility beliefs produced by Karahanna and Agarwal into the UTAUT model developed by Venkatesh and Morris. It also attempts to provide a better understanding of how the UTAUT model's cognitive phenomena are created by developing and testing new boundary conditions. Because the goal of the study was to look at the relationship between compatibility thoughts and behavioral perceptions, actual usage behavior was not taken into account. Furthermore, research was cross-sectional, avoiding the potential difficulty of retrospective analysis by evaluating behavioral intention rather than use behavior.

As the research identifies various factors that influence the use of blockchain technology in student information system, the study of adoption models becomes significant for analyzing the factors and its effect in adopting and diffusing as the technology is new. Two such adoption models are referred that are TAM (Technology Adoption Model) and UTAUT (Unified Theory of Acceptance and Use of Technology) Model. This research combines these two models, and a new conceptual interdependence model is designed that covers all the identified factors that influence the use of blockchain in the student information system management to be used in universities.

1.5 Challenges in managing student information system in education sector

Education is the process of exchanging knowledge and skills through a variety of mediums. If all parties involved have trust in each other, the process will be more efficient. This trust has the potential to alter higher education in the future. Because of its decentralization and immutability, blockchain technology has the potential to transform the education sector for the better. Fraud detection, universal academic credentials, smart contracts, decentralized classrooms, and scholarship openness are some of the problems facing the education sector. The above problems can be solved with blockchain technology. A blockchain is an immutable record-keeping system. It is not possible to modify the information once it has been entered and verified. Furthermore, no one can add data to the blockchain without the permission of the network's users.

According to Rachael Hartley, education is a diverse field in which many systems must change to educate students for future professions. Having a watertight system that records a student's academic history before and during their working lives might help not only with dishonesty, but also with tailored learning challenges. People will have the best opportunity of deciding their educational path and a successful future career because of this. It has the potential to enable workers to create a safe, verified digital record of their formal degrees, experience, and soft skills acquired during their careers. Furthermore, utilizing a smart contract, blockchain applications could provide students more control over their education by providing flexible access to information and courses recommended based on previous successes or failures, as well as accomplishment.

1.6 Purpose of research

The completed course student credential records of most universities are kept in proprietary format. These databases are designed to be utilized only by the personnel of that university in a dedicated online system with little to no interchange. The universities also have their own specialized system to which students can have external access in a restricted and password protected manner to view or print their completed course records. There are numerable important points regarding such systems which include storage location, standardization of data and safety. How to analyze, filter and securely share this data is also an important issue. Further, for legal reasons the educational institutes must maintain the anonymous nature of students' completed credentials. These records are mostly stored in different standards. This makes it difficult to exchange the credentials between different universities or stakeholders.

Some universities do not share their students' information, including finished course records, depending on the country's policy. As a result, students may find it challenging to transfer to another Institute or university. This challenge is exacerbated when a student wishes to transfer to another nation, where there are additional language, script, and administrative restrictions. When a student applies for a job in a foreign nation and must show his academic degree, challenges emerge owing to the inaccessibility and lack of standardization of the centralized storage of students' complete course data. Students must translate and notarize their academic certificates, which is a time-consuming and complex process.

The notarization of papers entails the translation of all official documents into the language of the applicant institution, which is nevertheless subject to examination and validation to ensure that the content is identical or similar. Many graduates face the challenge of not having access to an online academic grading system. If a student loses his academic certificates in this situation, he must return to his home institute and obtain a replacement copy, which is a costly and time-consuming process. Despite the existence of some unified academic credit standards, such as the ECTS, the adoption and implementation of a global decentralized, trusted, and secure credit platform is a difficulty. Many of the roadblock's stem from the fact that students' academic records are confidential and subject to stringent management requirements. With an increasing number of diploma mills throughout the world issuing fraudulent degrees and diplomas, there is a pressing need for a safe and reliable storage and record system. Blockchain technology is a safe solution to this. Using blockchain in managing the student data could be useful in avoiding data tampering, achieving trust-based student credential verification etc. Since 2009, use of blockchain has spread widely in almost all the domains. Even western countries have successfully adopted blockchian in education sector. In India there is no awareness of effectiveness of using blockchian in university information system. This research tries to find out this reason.

The purpose of the research is to identify the factors that determine universities intention to use blockchain. Various related factors of TAM and UTAUT Model that are dependent on the use behavior, are investigated and analyzed. This research proposes to employ a blended interdependence model which is designed using combo model of TAM (Technology Acceptance Model) and UTAUT (Unified Theory of Acceptance and Use of Technology. This is meant to serve as a comprehensive model that can be applied across a range of applications. This model will help to provide an advice concerning the selection of blockchain use case for universities in west India. The factors of blockchain are identified by conducting survey-based research at various universities located in west India through questionnaire and interviews. The findings are then triangulated by considering identified factors and a blended interdependence model is developed showing stages of adoption of blockchain technology for universities in West India.

1.7 Problem Statement

In any student information system, almost all transactions are centralized through third-party organizations which need to be trusted. When a student graduates, the employer first requests an official transcript as proof of completion of his graduation. In this situation, the university serves as a trusted intermediary between the student and the employer, with the responsibility of ensuring that the information provided is correct and truthful. The student is never directly asked to give a copy of their transcript by the employer. The reason for this is that the student could modify the data or content. The true service or commodity offered by a third-party is basically trust. The current way of managing the student data in universities is the centralized database management System.

Following issues are frequent in current Centralized Data Management System:

- Possibility of data manipulation by owner of database.
- Risk of data tampering.
- Difficulty in verification of student data.
- Difficulty in data distribution among system stakeholders.
- Difficulty in presenting information to users

To overcome these, a decentralized hyper-ledger framework could be developed wherein data tampering is avoided and it will be encrypted at all stages of user stakeholders. This hyper ledger technology is blockchain. Many domains have initiated the use of this blockchain. It is found that there is little awareness of this blockchian when it comes to education sector in India. Despite knowing the drawbacks of the centralized database management system, universities hesitate in exploring new kind of databases like blockchain. This study aims in understanding the actual problem behind this hesitation

1.8 Objectives for study

1. To study the factors that influences the use of blockchain technology in student information system in universities.
2. To develop a blended interdependence model which includes TAM, UTAUT and use behavior of blockchain technology.
3. To understand the degree of the relationships between the variables of the interdependence model.
4. To interpret if the universities will opt for the blockchain technology in their student information system based on different categories of the demography.
5. To suggest ways to implement blockchain technology in the universities.

1.9 Research Questions

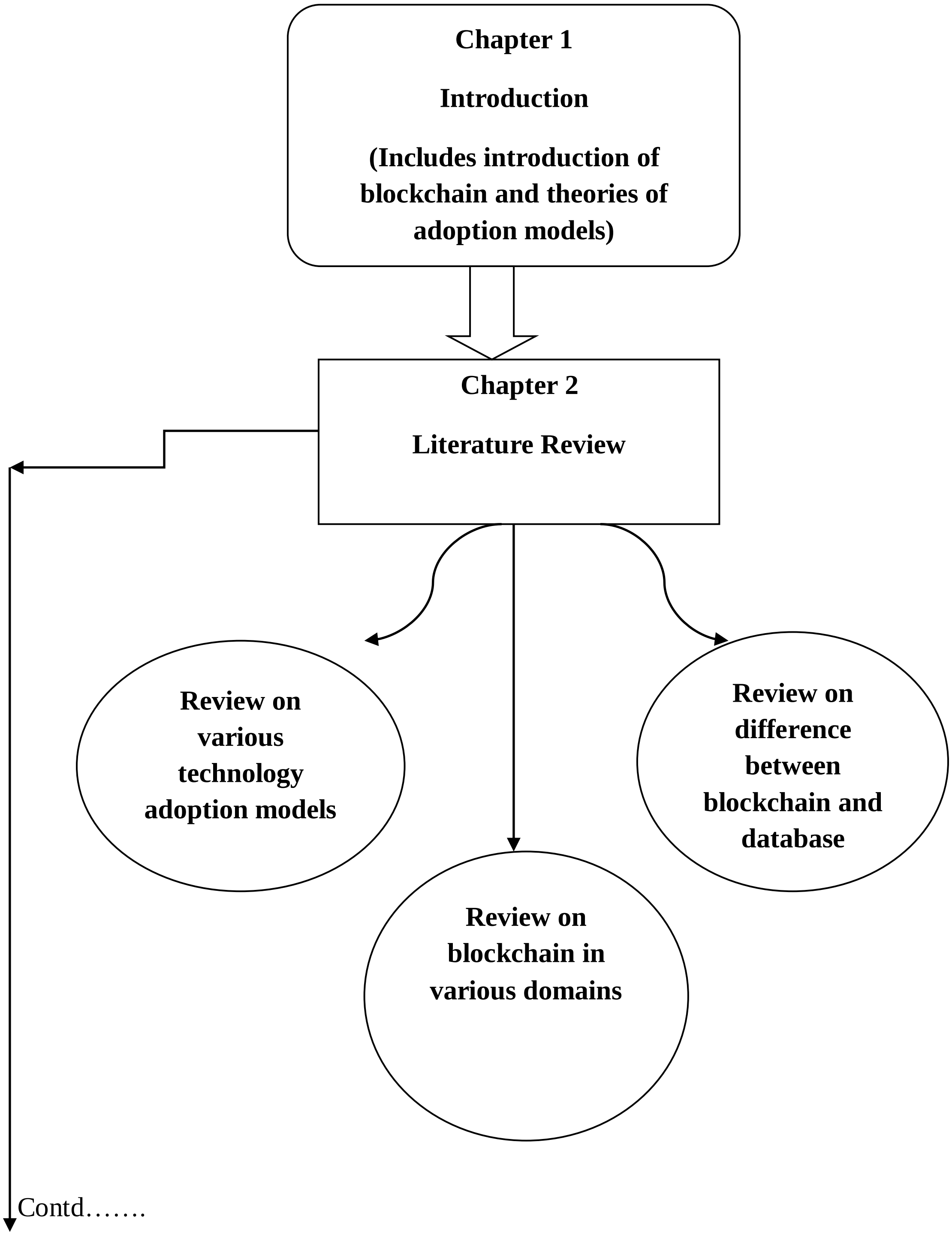
Q-1: What are the factors that influence the use of blockchain technology in university information system?

Q-2: How are UTAUT model factors related to blockchain technology adoption in university information systems?

Q-3: How are TAM model factors, related to blockchain technology adoption in university information systems?

Q-4: What could be an absolute method to implement blockchain technology in university information system?

1.10 Organization of thesis



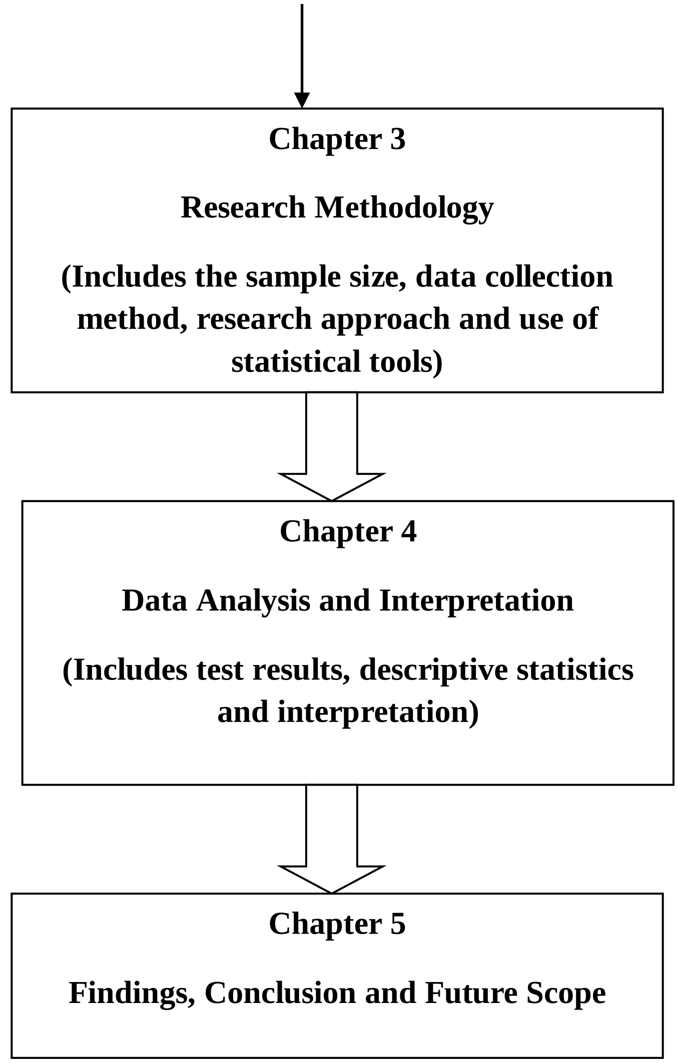


Fig: 1.5 Structure of Thesis

The detailed remainder of this report encompasses the following chapters:

Chapter 2 provides a literature review of blockchain enabled education systems, agent-based modeling, and simulation. This chapter also covers all the specific domains such as supply chain, retail, agriculture, health care system, research, logistics etc where the blockchain is successfully implemented.

Chapter 3 presents the methodology including proposed model, simulation framework, agents, parameters, and state variables. This chapter also includes the use of tests, selection of data collection tools, defining of population, sample size, and brief of use of statistical tools.

Chapter 4 This chapter includes the results and discussion found during the analysis. It also includes the data interpretation of general descriptive statistics in form of pie charts and tables

Chapter 5 presents the conclusions and future scope of this research summarizing the outcomes of the analysis and gives recommendations for future work.

Chapter 2

Literature Review

This chapter introduces the literature review and provides information on literature search and inclusion criteria in section 2.1. The theories of blockchain constructs utilized in diverse areas are covered in the remaining sections from 2.2 to 2.53. It also discusses the importance of all adoption theories that are relevant to blockchain adoption and diffusion. Few sections also give a basic overview of how blockchain is implemented, as well as its benefits and drawbacks.

2.1 Introduction

A research dissertation's most important chapter is the literature review. It is a step-by-step method for locating, examining, and evaluating published and unpublished literature relevant to a certain subject. It aids in calculating the number of studies contributed by previous researchers, identifying research gaps, and establishing new study objectives. The literature review offers a concise and comprehensive description of key literature related to the research problem, as well as recommendations for medical strategies and methods for carrying out future research. The literature review aids researchers in creating a study timeline, defining a research problem, developing study questions, and constructing study hypotheses.

Fig 2.1 shows summary of context of literature review chapter wherein the chapter is divided into three basic entities, first, general context, second favorable outcomes and third, overview of limitations of each previous research.

The general context refers to the various use cases of blockchian that includes supply chain management using blockchain, retail industry, logistics, agriculture, health care etc. The content describes the advantages and disadvantages of use of blockchain in the respective domains. The favorable outcome context refers to the overview of strategic, tactical, and operational factors that affect the use of blockchain technology in finance industry and other sectors. The limitations include the description of all the actual dependent and control variables that are hard to decide and analyze the use cases of blockchain

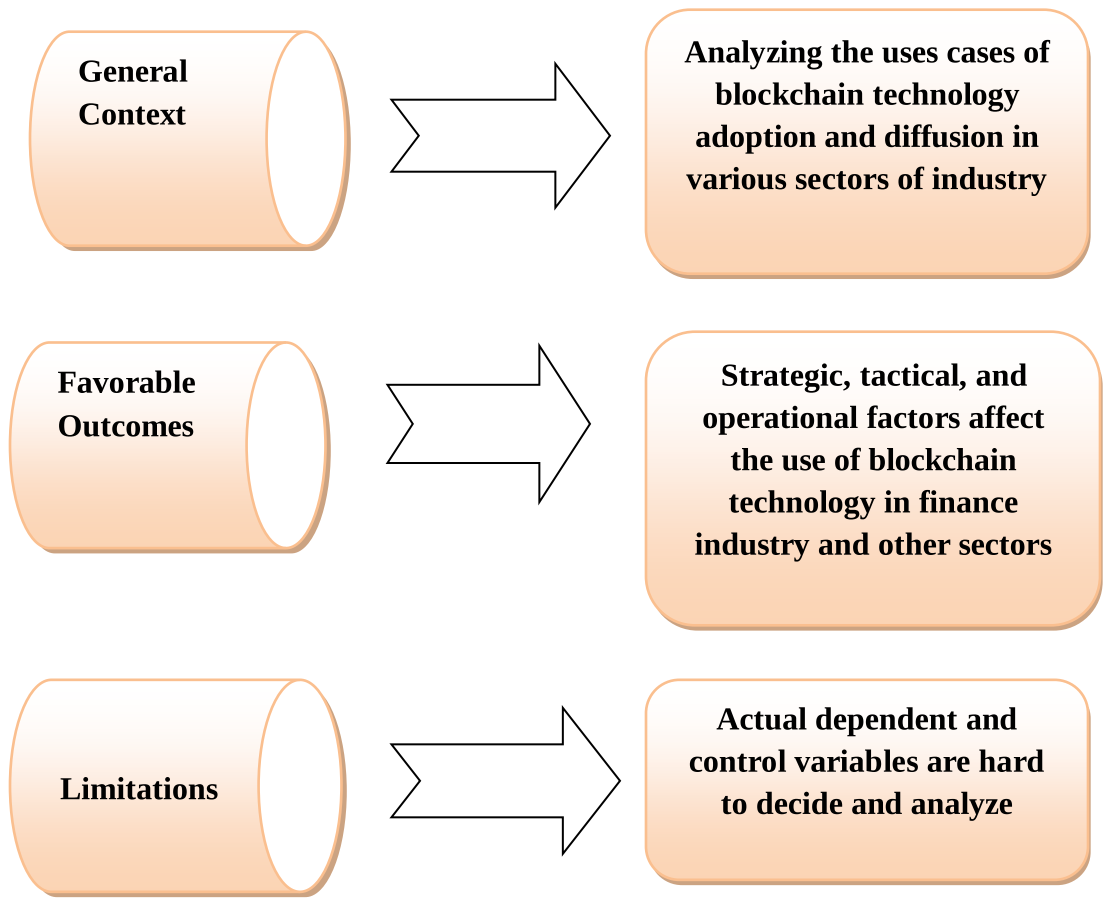


Fig: 2.1 Brief summary of context of literature review

Source: By Author

The following published research papers and few theses on blockchain adoption and diffusion have been studied to identify the research gap.

2.2 Evolution of theories and models of technology adoption

(Rajesh Sharma and Rajhans Mishra, 2014), in their study "A Review of Evolution of Theories and Models of Technology Adoption", used a survey of the current literature on the issue to discuss the evolution of research in the domain of technology adoption across time. The research is being carried out with two goals in mind. The initial goal of this work is to give academics that plan to use these models in their research an overview of this crucial subject. The study's second goal is to look at the need to find new constructs that could be utilized to explain the adoption of emerging technologies like e-government, cloud computing, and mobile government, as well as to build on the theoretical underpinnings of the existing body of knowledge.

This research covers all the adoption models with their identified constructs which are summarized as follows:

Diffusion of Innovation Theory: The innovation, communication channels, time, and social system.

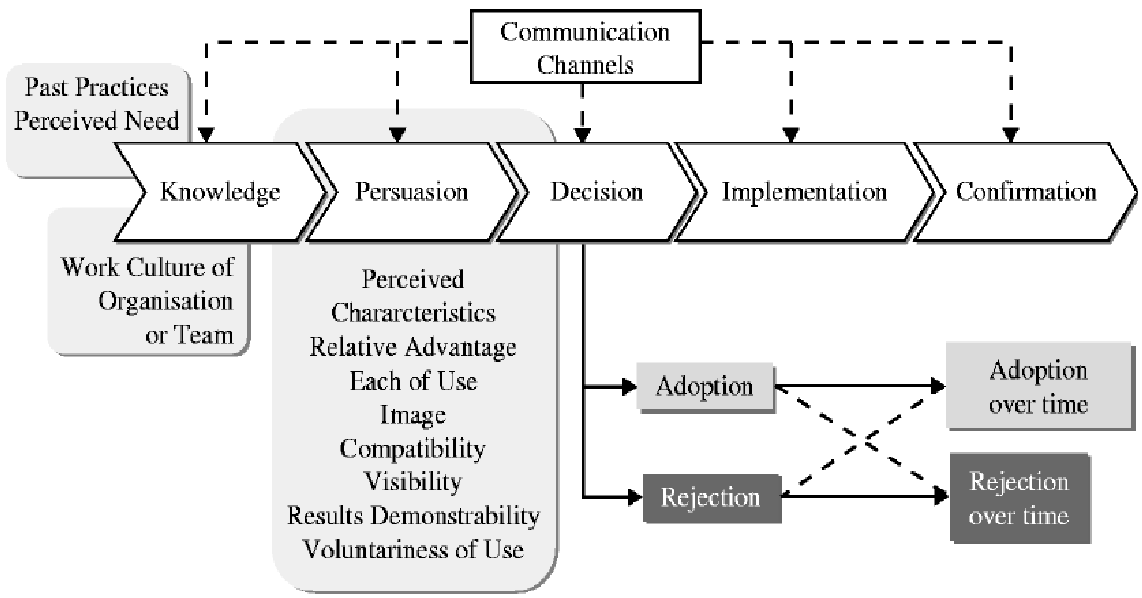


Fig: 2.2 Diffusion of Innovation Theory

Source: https://sites.google.com/site/instructionaldesignknowledge/diffusion-of-innovation-theory

The theory's core assumption is that four factors impact the dissemination of a new idea: invention, communication channels, time, and the social structure. As demonstrated in fig 2.2, the dissemination process has five stages: knowledge, persuasion, decision, implementation, and confirmation. Users are divided into six groups: innovators, early adopters, early majority, late majority, laggards, and leapfroggers.

Theory of Reasoned Action: Behavioral intention, Attitude (A), and Subjective Norm

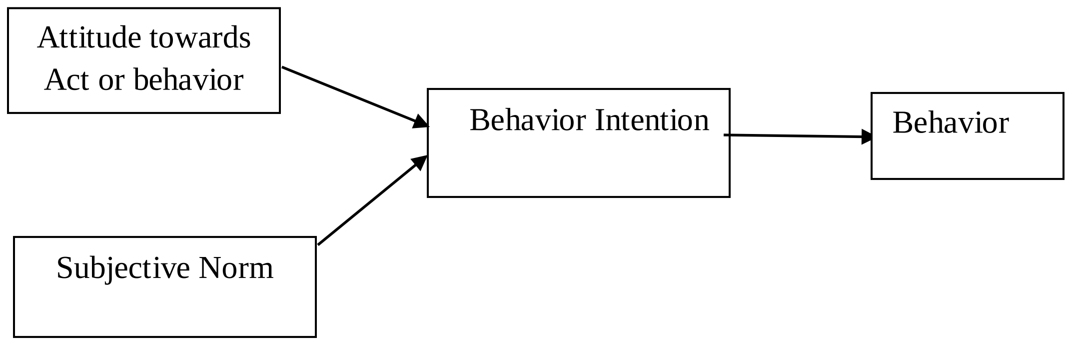


Fig: 2.3 Theory of Reasoned Action

Source: https://www.researchgate.net/figure/Theory-of-Reasoned-Action-TRA-Fishbein-Ajzen-1975_fig1_284014676

"Behavioral intention (BI), attitude (A), and subjective norm (SN)" are the three general constructs proposed by the theory. A person's behavioral intention, according to TRA, is determined by his attitude and subjective norms. As illustrated in fig 2.3, behavioral intention can be interpreted mathematically as the sum of attitude and subjective norms. Furthermore, if a person's desire to conduct in each way is strong enough, it is likely to convert to action.

Theory of Planned Behavior: Behavioral intention, Attitude (A), and Subjective Norm, Perceived Behavioral Control.

To the constructs attitudes and subjective standards that make up the Theory of Reasoned Action, the Theory of Planned Behavior adds the idea of Perceived Behavioral Control (PBC), as depicted in fig 2.4. "People's impression of the ease or difficulty of doing the behavior of interest" is referred to as "perceived behavioral control." Self-efficacy, according to the idea, is the most essential determinant of behavioral change since it leads to the development of coping behavior.

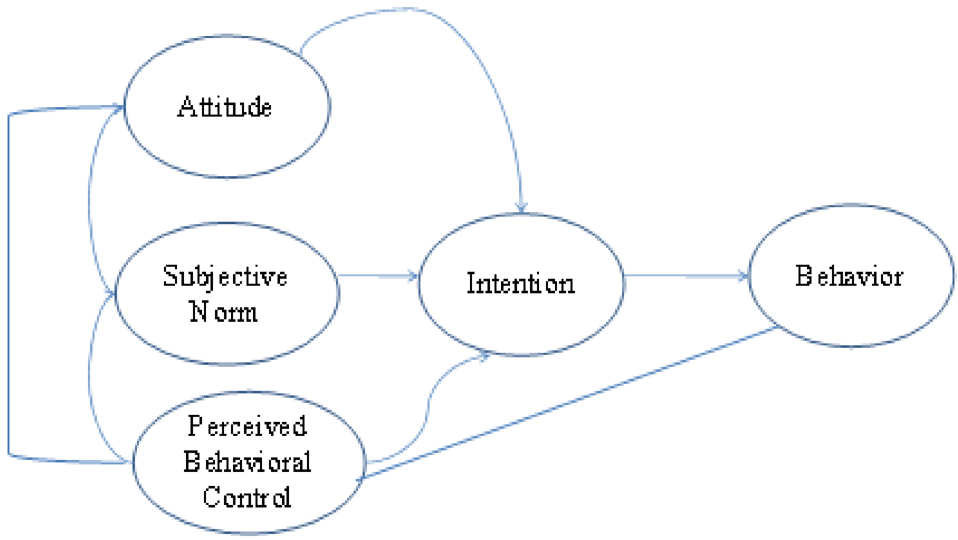


Fig: 2.4 Theory of Planned Behavior

Source: https://link.springer.com/10.1007/978-3-319-28099-8_1191-1

Social Cognitive Theory

The Social Cognitive Theory (SCT) focuses on the concept of self-efficacy, which is defined as "a person's assessment of their capacity to use technology to do a specific job or task." According to SCT, the user's behavior is driven by the user's expectations of personal and performance-related improvements. The anticipation of outcome of both categories is influenced by self-efficacy. While a person's self-esteem and sense of accomplishment are linked to personal result expectations, job-related outcome expectations lead to performance-related expectations.

According to SCT, the users' behavior is influenced by two conflicting elements. The component "affect," which refers to how much a person enjoys his or her employment, makes a positive contribution. On the other hand, the component "anxiety," which is a person's uncomfortable reaction when executing a task such as trying to use a computer with which they are unfamiliar, has a negative impact on desired behavior. In adoption studies, this hypothesis has been frequently applied.

Technology Adoption Model: Perceived usefulness and perceived ease of use.

In technology adoption research, the Technology Adoption Model (TAM) has been frequently employed. The model's strength comes in its simplicity, as it only uses two constructs, "perceived utility" and "perceived ease of use," to predict the extent of new technology adoption at the individual level, as illustrated in fig 2.5.

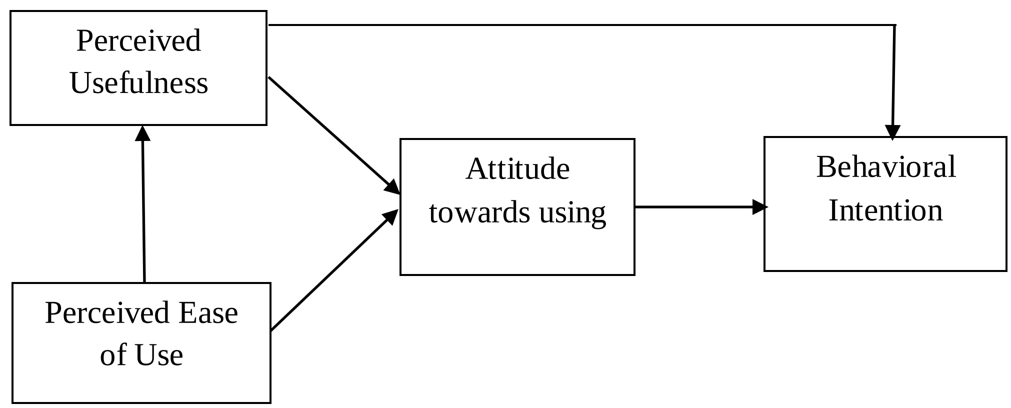


Fig: 2.5 Technology Acceptance Model

Source:https://www.researchgate.net/figure/Illustration-of-the-Technology-Acceptance-Model-TAM_fig1_228631114

These constructs are based on Bandura's Self Efficacy Theory, which defines perceived ease of use as "judgments of one's ability to execute courses of action required to deal with a potential circumstance." TAM was first tested in the context of IBM Canada's deployment of an email service and a file editor, with 14 items on each of two components. TAM became well-known over the next ten years as a reliable, powerful, and cost-effective model for predicting consumer acceptance.

The Model of PC utilization

Job-fit, complexity, long-term consequences, affect towards use, social factors, facilitating conditions. The concept is based on Triandis' theory of human behavior, which differs from the Theory of Reasoned Action in that it distinguishes between the cognitive and affective aspects of attitudes. Beliefs are a part of the cognitive side of attitudes. "Behavior is governed by what people would like to do (attitudes), what they believe they should do (social norms), what they have usually done (habits), and the predicted consequences of their behavior," according to this idea. This idea focuses on the amount to which a worker uses a computer when the use is not mandated by the company but is at the user's discretion. In such a situation, the theory suggests that the worker's computer use is likely to be influenced by several factors, including his feelings (affect) toward using computers, prevalent social norms regarding computer use at work, general habits related to computer use, expected consequences of using the computer, and the extent of conditions at work that facilitate PC use. In fig 2.6, these structures are represented.

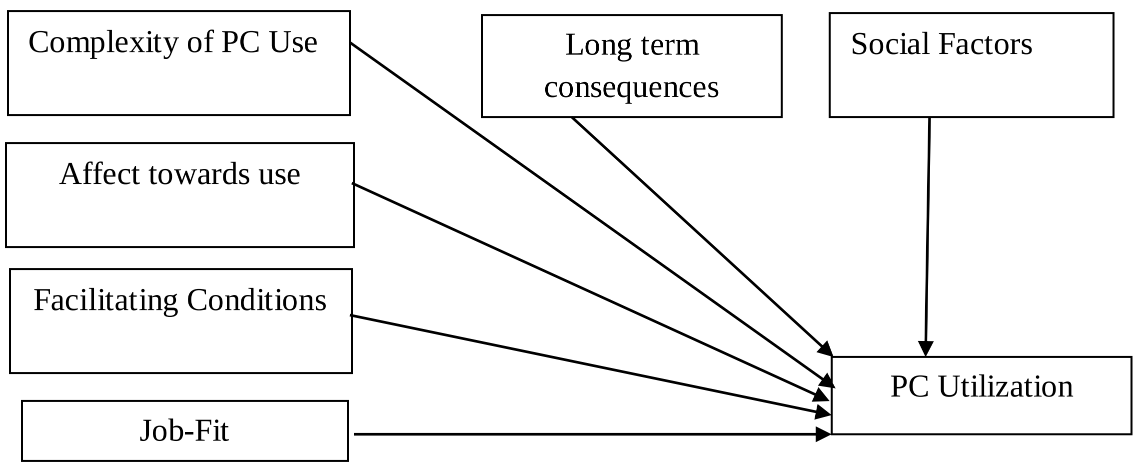


Fig: 2.6 The Model of PC Utilization

Source: https://www.researchgate.net/figure/Model-of-PC-Utilization-MPCU_fig4_340793380

The Motivation Model

Extrinsic motivation (such as perceived usefulness, perceived ease of use, and subjective norm) and intrinsic motivation (such as perceptions of pleasure and satisfaction). The Motivation Model's primary concept is that users' behavior is shaped by both extrinsic and intrinsic motives. Extrinsic motivation is described as the belief that people desire to do something "because it is considered to help them achieve desirable goals that are not related to the activity itself, such as better job performance, compensation, or promotions" (Davis et al., 1992, p. 1112). Perceived utility, perceived simplicity of use and subjective norm are examples of extrinsic motivation. Intrinsic motivation, on the other hand, is defined as behavior that results in a feeling of joy and satisfaction for the individual, (Vallerand et al. 1997).

Extended TAM2 model: Social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability and perceived ease of use).

In their extended TAM model, Venkatesh and Davis modified TAM to include additional significant determinants of TAM's perceived usefulness and usage intention dimensions. Social influence processes (subjective norm, voluntariness, and image) as well as cognitive instrumental processes (job relevance, output quality, outcome demonstrability, and perceived ease of use) were incorporated as extra constructs, as shown in fig 2.7.

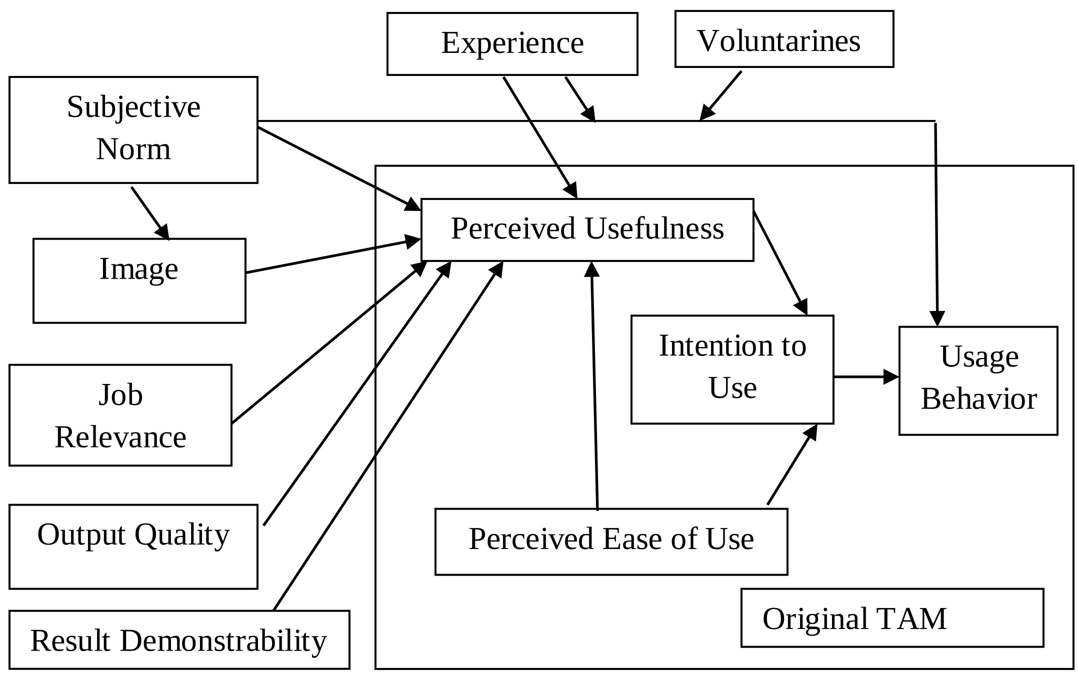


Fig: 2.7 Extended Technology Acceptance Model 2

Source: https://www.researchgate.net/figure/Extended-Technology-Acceptance-Model-2-Source-Venkatesh-Davis-2000_fig3_340621117

UTAUT (Unified Theory of Acceptance and Use of Technology): Performance expectancy, effort expectancy, social influence and facilitating conditions.

(Venkatesh et al. 2003) proposed UTAUT after conducting a systematic assessment and consolidation of the constructs of the previous eight models (TRA, TAM, MM, TPB, TAM2, DOI, SCT and model of personal computer use). It is intended to be a comprehensive model that may be used in a variety of situations. Fig 2.8 depicts the four important constructs: "performance expectancy, effort expectancy, social influence, and facilitating conditions."

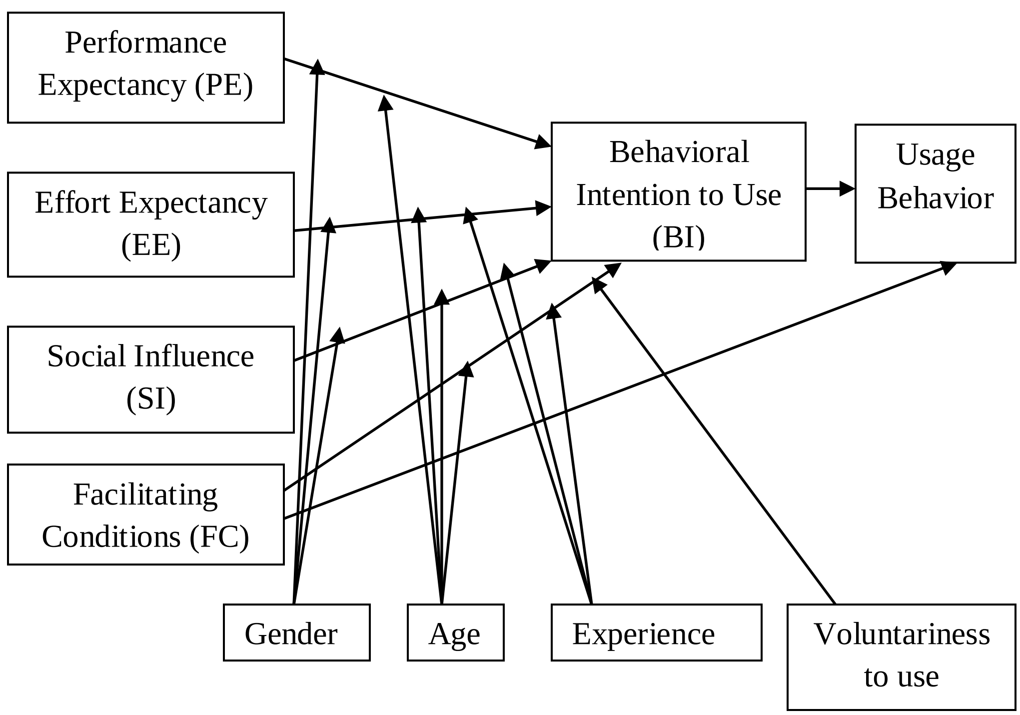


Fig. 2.8 UTAUT Model

Source: https://www.researchgate.net/figure/The-research-model-UTAUT-Venkatesh-et-al-2003-The-UTAUT-model-uses-four-core_fig1_283503814

MAPS (Model of Acceptance with Peer Support): Behavioral intention, system use, facilitating conditions, network density, network centrality, valued network centrality, and valued network density.

The Model of Acceptance with Peer Support (MAPS) combines past research on people with relevant social network components in a way that helps to broaden the reach of earlier ideas. According to the authors, there are two sorts of social relationships. The first link between employees is seeking assistance from coworkers, which can lead to increased knowledge on how to use the system. Another type of connection that exists between employees is that of assisting and assisting coworkers to improve their grasp of system configuration and deployment.

"Get-help" and "give-help" ties are the names given to these ties. The authors suggest two new concepts: "network density" and "network centrality," which correspond to the concepts of "get-help" and "give-help," respectively. Theoretically, these dimensions are based on previous social network research and are presented as important determinants of system use. By considering the scope of the system's resources, information, and expertise, these constructs are further expanded as "valued network density" and "valued network centrality." These constructs are thought to have the potential to operate as supplementary predictors. The review provides identifies several new areas of research where the existing models of technology adoption may prove to be inadequate.

2.3 Detailed blockchain domain

(Ibrar Ahmed, Shilpi, Mohammad Amjad, 2018) in their research “Blockchain Technology: A Literature Survey”, stated that advanced from the Merkle Tree, blockchain technology is a completely decentralized computerized register which keeps a safe history of information trades. The decentralization part of blockchain technology does away the need of any focal expert for overseeing it. In this paper authors presented an exhaustive outline on blockchain innovation. They start by revealing insight into the basics of blockchain technology then we examine some normal calculations utilized in different blockchains. Blockchain, the establishment of Bitcoin, has gotten broad consideration as of late. Being an ineradicable information putting away innovation, blockchain can be utilized in monetary resources as well as anything which has some worth. Blockchain likely could be seen as a public record, and each submitted dealings is place during a rundown of squares. This chain creates as new squares are mounted to that perpetually. With a terribly planned information stockpiling structure, exchanges in Bitcoin framework may happen with no outsider and hence the center development to build Bitcoin is blockchain. The blockchain innovation has key characteristics of decentralization, determination, obscurity, and auditability. With these properties, blockchain will extensively save the cost and upgrade the usefulness.

Blockchain could be an arrangement of squares that holds a whole rundown of managing records like standard public record. With a past block hash contained inside the square header, a square has only one parent block. Its cost noticing that uncle blocks (offspring of the square's precursors) hashes would even be hanging on in ethereum blockchain. The essential square of a blockchain is named beginning square that has no parent block. A square comprises of the square header and the square body. The square header incorporates: Block adaptation, Merkle tree root hash, Timestamp, nBits, Nonce, Parent blocks hash. Blockchain has following key qualities: Decentralization, Persistency, Anonymity, auditability. Blockchain experience the ill effects of some significant issues. The extent of exchange is amplifying as time passes thus does the responsibility of blockchain. Unnecessary exchanges make the framework massive. The size of squares is additionally an issue while conveying greater exchange. Being minuscule in size, it can just contain a limited quantity of information at a time. Albeit the security is ensured in blockchain innovation be that as it may to be exact, the keys of public and private exchange can just protect a restricted measure of security. While making the exchange, the obscurity of the clients is kept up with. Notwithstanding, it is displayed in that blockchain can't ensure the value-based security since the upsides, everything being equal, and equilibriums for every open key are freely noticeable. The absolute first application and utilization of blockchain was Bitcoin. In the current situation, monetary circle has felt the presence of blockchain innovation the most. Another application is "Keen Contracts". As the name proposes, a shrewd agreement is a computerized trade convention that executes the provisions of an understanding. Settling on agreements and arrangements brilliant was however of long back, presently with the approach of blockchain innovation, this can be figured it out. The explanation of finance being the biggest client of blockchain is the straightforwardness it gives to the gatherings of dealers and financial specialists while exchanging and making exchange. Exchanges occurring in any element be it private or public can be put away in the squares and authenticity of the equivalent can be subsequently confirmed.

2.4 Blockchain Constructs

(Joe Abou Jaoude, 2018) in his research work, studies blockchain's uses and applications in several disciplines, as well as a theoretical model for its acceptance as the underpinning technology for present and future information systems. While Bitcoin had many unique features and innovations that aided in its adoption, such as proof of work and digitally limited supply, it is blockchain that stands out as the key innovation whose applications appear to be spreading beyond Bitcoin and the financial services sector in general, into mainstream use across various industries and technology applications. Immutability, decentralization, asymmetric encryption, and smart contracts are three properties that make it an appealing and valuable tool in today's digital age. Blockchain can encrypt a grouping of transactions into blocks using cryptography and hash functions, with specific hash functions created automatically because of the content in the block. Any change to the block would result in a change to the hash function, and because all blocks are linked together by the inclusion of the current and previous hash keys in each block, modifying one block would necessitate decrypting and changing all prior blocks on the chain.

This feature has various benefits, including the ability to keep all information secure and transparent while considerably decreasing the danger of an attack, allowing the system to exist and operate without the assistance of trusted third parties and intermediaries. Six blockchain application areas (Finance, Insurance, Education, Supply Chain, Healthcare, and Energy), one paradigm (IoT and Smart Cities), and six business categories emerged from the study' conclusions (Transportation, Business Process Management, Fraud detection, Exchange, Resource Management and Rights Management).

The Internet of Things appears to be viewed as an all-encompassing concept. Many business domains have yet to be handled by blockchain. Manufacturing, production, operations, purchasing, marketing, and sales, customer connections, information technology, adoption, anxiety, outsourcing, logistics, business development, human resources management, and risk management are just a few of the areas covered.

Furthermore, there are many other sectors (besides energy and healthcare) and bodies that must consider blockchain, including but not limited to: aviation and aerospace, pharmaceuticals, not-for-profit organizations, the United Nations, hospitality and tourism, real estate, retail, politics, economic development, the environment, and sports. We feel that blockchain technology has a lot of potential because it makes a bold and ambitious proposition to human evolution. It could alter the path of human history. Researchers have just recently begun to examine the shape and function of blockchain technology with their minds, based on the findings of this study. At the same time, it appears that businesses are wary of experimenting with it, possibly due to fear (or a lack of knowledge). The utility of blockchain's decentralized nature in democratizing the energy supply and demand business while enabling a more scalable and adaptable solution for the world with consumers alternating as providers on the energy grid was the focus of most blockchain research on energy.

The privacy and anonymity capabilities of the blockchain allow for the inclusion of numerous customers and suppliers in the market, as well as the establishment of microgrids in the energy sector, while preserving the data consumption and pricing preferences of those involved in the transactions. The decentralization of patient data, which allows users instant and quick access to their vital medical information from anywhere in the globe rather than having to go through the service provider, is also suggested to promote and grow innovation in the healthcare sector.

According to the study, blockchain research is rapidly expanding, with a distinct evolution pattern among the various layers and concepts of blockchain implementation, with initial research focusing on blockchain's first application Bitcoin, then progressing to studying the underlying technology itself in the last three years, while gradually shifting from blockchain improvement related works into application papers. Blockchain applications differ in their use across domains, impacting particularly government through the decentralization of databases and computing power; finance through security and anonymity for financial transactions; energy by creating efficient anonymous micro power grids capable of withstanding security attacks; healthcare through the democratization of data and promotion of medical research and innovation and internet of things through the security and anonymization of private information while enabling quick communication and updates across devices.

This intense interest is most likely due to the likelihood that such industries would benefit from the unique combination of benefits that blockchain brings to the market. Due to a lack of consumer understanding as well as the general obstacles surrounding its use, combined with the entire hype developed around its reliant system of cryptocurrencies, blockchain provides a new difficulty, preventing users from directly experiencing the technology.

Furthermore, compared to past electronic commerce implementations, the decentralized nature of blockchain presents a significantly distinct advantage/disadvantage combination. The traditional value proposition of most systems is likely to be reversed as improved anonymity and security at the expense of reputation and trust through an intermediary. As a result, to continue research on blockchain technology acceptability, metrics of perceived utility, risk, reputation, intention to transact, familiarity, comfortability, trust, perceived security, and perceived privacy are required.

2.5 Various blockchain domains

(Supriya Thakur Aras, Vrushali Kulkarni, 2017), in their study, covered various blockchain domains. According to them, blockchain has been dubbed the fifth disruptive computer invention. In simple terms, it is an immutable and verifiable distributed ledger of records. The notion of blockchain has been applied in a variety of ways since its inception in 2008. The most significant impact or application is the proliferation of cryptocurrencies. With time, however, it has become evident that blockchain as a technology will have far broader and deeper implications than merely bitcoin and distributed ledger storage. This in-depth assessment aims to compile all of the major breakthroughs in blockchain implementation thus far. While the most popular application of blockchain is in finance and banking, many large companies are experimenting with it in a variety of other fields.

This study looks at the several areas where blockchain has had an impact and where future deployments are likely. The fact that blockchain technology eliminates two of the most hated difficulties of currency-based transactions, which have long mandated the use of a third party to validate the transactions, is a huge benefit. The Byzantine Generals' Problem and the Double Spend Problem are two well-known examples.

The study illustrates how a non-tokenized method can use blockchain as a notion. The paper also discusses blockchain taxonomy and how transitioning from permissionless to permissioned blockchain becomes necessary to solve certain types of challenges where confidence is crucial and a public permissionless ledger appears to be both a danger and an overhead. Nakamoto's original concept for blockchain implementation was that of a public, decentralized ledger.

The deployment of the most prominent blockchains, such as Bitcoin and Ethereum, has been similarly successful. In theory, four types of blockchains can be established based on who can access the blockchain network and how permissions to publish to the blockchain network are assigned: Anyone with computational power can join, and there are no restrictions. Permissioned - Only approved users have access. Public – Anyone with access can make changes, while Private – Only particular people can make changes. All are welcome to use public blockchains. Anyone can join them to submit transactions and participate in the mining and consensus process for adding new transaction blocks to the blockchain. For consensus, these blockchains often use Proof of Work (PoW) or Proof of Stake (PoS).

Having a larger number of participants is beneficial to this model since it lessens the likelihood of a 51 percent attack. Organizations typically create permissioned blockchains to meet their specific business needs. These blockchains are likely to have interfaces with the organization's existing applications. Organizations may use consortium blockchains, in which only a few trusted parties must sign off on a transaction. The write permission over the blockchain is granted to a central organization in fully private blockchains. The blockchain eliminates the requirement for a third party to carry out transactions on your behalf. This indicates that the network's consensus mechanism must be present. The strength of a blockchain network is determined by how it executes its consensus process.

To ensure sanity and data coherence among the participating nodes of the network, a failsafe consensus process that is adequate for the purpose (of the blockchain in question) is required. The consensus mechanisms of blockchain are primarily designed to overcome two well-known issues with digital currency: the problem of double spending and the Byzantine Generals dilemma. Non-fiat money has the greatest regulatory hurdle. The rate of technological advancement is outpacing the rate of regulatory catch-up. From fiat currency to e-money to virtual currency to cryptocurrency, the order of monetary evolution has changed. Cryptocurrency is the world's first decentralized currency. The inherent constraints and limits of blockchain are well-known. Because of the peer-to-peer network operation, it consumes a lot of energy and wastes a lot of it per unit of processing.

In a Proof of work-based blockchain system, all network nodes compete to add the block, but only one node succeeds each time. As a result, while other blocks contributed to the transaction validation and verification process, their efforts are practically useless if the provided transaction block is not added. Finally, faith in the long-term viability of blockchain technology is growing in a slew of blockchain-based applications and experiments. To make blockchain more adaptable for larger businesses, researchers are focusing on scalability and consensus algorithms. Taxation, education, and insurance are among of the areas where blockchain adoption has yet to make a significant impact, and they could be the focus of future blockchain research.

2.6 Security issues and challenges in blockchain

(Iuon-Chang Lin and Tzu-Chun Liao, 2017), in their research presented various issues related to use of blockchain technology. Out of which following are the major ones:

The Majority attack (51% attacks): The likelihood of mining a block with proof of work is determined by the miner's work (e.g. CPU/GPU cycles spent examining hashes). As a result of this mechanism, people will want to band together to mine more blocks, forming "mining pools or places where the most computational power is concentrated. It will be able to control this blockchain once it has 51 percent computational power. It appears to be a security risk. If someone has more than 51% processing power, he or she can determine nonce value faster than others, implying that he or she has the right to choose which block is allowed.

Fork issues: The fork issue is related to the decentralized node version and software upgrade agreement. It's a critical issue because it touches on so many aspects of blockchain. Hard forks and soft forks are the two most common types of forks.

When a system gets a new version or agreement that isn't compatible with earlier versions, the old nodes can't consent to the mining of new nodes, and the chain splits into two. Even though the computational capacity of new nodes is greater than that of old nodes, old nodes will continue to maintain the chain, which they believed was correct. When a system gets a new version or a new agreement that isn't compatible with the previous version, the new nodes can't agree to mine the old nodes. Because new nodes have more computational capacity than old nodes, the block mined by the old nodes will never be approved by the new nodes, but both new and old nodes will continue to work on the same chain

Current regulations problems: For example, the characteristics of a decentralized system will weaken the central bank's ability to control economic policy and the amount of money, making governments wary of blockchain technologies. Authorities must investigate this new issue and formulate new policies as soon as possible, or else market risk will arise.

Integrated cost problem: Of course, changing an existing system comes at a high cost in terms of both time and money, especially when it comes to infrastructure. It is necessary to ensure that this innovative technology not only generates economic benefits and meets regulatory standards, but also bridges the gap between traditional and modern organizations.

2.7 Blockchain revolution

(Hanna Halaburda, 2018) in her research, “Blockchain revolution without the blockchain”, stated that the innovation behind blockchain has drawn in a great deal of consideration. In any case, this innovation is generally not surely known. There is no agreement on what benefits it might bring or on how it might fall flat. A cautious investigate the innovation tracks down that most of the proposed advantages of alleged blockchain advancements don't actually come from components special to blockchain. All things considered, they come from more customary components like encryption and keen agreements. Additionally, even those applications that would profit with an appropriated framework may profit more from a circulated data set planned uniquely in contrast to blockchain. A more cautious investigate the innovation uncovers that most of the proposed advantages of alleged blockchain advances don't really come from blockchain. What gets packaged up as blockchain advances—shrewd agreements, encryption, and a circulated record—are isolated ideas. The three might be carried out together. Disarray around blockchain can be followed to the beginning of the term. The expression "blockchain" was presented as shorthand for a "chain of squares of exchanges," which was important for the Bitcoin framework. Accordingly, in the Bitcoin setting it implied a "conveyed record of exchanges." Later, "blockchain" turned into an autonomous term in media conversations of whether there are different utilizations for circulated records of exchanges past Bitcoin. Bitcoin's blockchain has these properties since it is a piece of the Bitcoin framework. Other circulated frameworks will be unable to support these properties. This is on the grounds that the Bitcoin framework is substantially more than simply the blockchain. The framework additionally includes local cryptographic money (bitcoins), mining and different components. Changing the components of the framework, e.g., by eliminating the local cryptographic money, or by changing the confirmation of-work instrument, influences the motivating forces of the members, and subsequently may adjust the properties of the conveyed record that is upheld by this altered framework.

The bitcoin framework took into consideration extra remarks alongside the exchanges, which gave simple capacity to make code that, would consider programmed execution of certain exchanges. Ethereum developed this element, presenting a blockchain with the fundamental motivation behind working with savvy contracts. Traditional press' utilization of the expression "keen agreements" exclusively with regards to blockchain may have made the discernment that shrewd agreements are local to blockchains. Subsequently, keen agreements, encryption, and dispersed record are isolated ideas. They might be executed together, however don't should be. The expression "blockchain" ought not to be utilized as a catch-all total of these various terms. Keen agreements are PC programs that naturally execute the conditions of an understanding between parties.

One model commonly given is that of a vehicle rent: upon a missed installment, the vehicle would consequently bolt, and control would get back to the moneylender. Since execution of a keen agreement doesn't include a choice or an activity by a human, it could be quicker and limit the quantity of errors. Both the sped up and decrease in mistakes would bring about cost investment funds.

Encryption, which builds the security of a PC framework, may likewise bring about tremendous expense investment funds. At present, encryption is underutilized in business practice. For instance, as of not long ago open private key encryption was regularly used to sign into a business' data innovation framework, however whenever clients were conceded into the framework, there was a few, yet little assurance. It has demonstrated to be a test to make a decentralized, permissionless, and secure blockchain to move resources other than a local digital currency (for instance, bitcoins for the Bitcoin blockchain).

The main significant test is the door issue: the data about the basic resources needs to enter the blockchain in any case. For instance, assume we need to utilize a blockchain to record and move land-proprietorship titles. To start this cycle, a door needs to authenticate that a particular plot of land exists and to dole out it to an underlying proprietor. Regardless of whether the entryway is an individual, an establishment or a consortium, it should be a confided in outsider for resulting clients of the blockchain. The subsequent significant test is guaranteeing permanence of the record without local cash. Recollect that Bitcoin's virtual changelessness comes from encryption as well as from the motivations inserted in the framework. What makes the record changeless is the way that adding a square to the blockchain is exorbitant. An organization member (say, a Bitcoin digger) necessity to consume huge assets to win the competition (to be the fastest to discover an answer for a riddle), which grants that member the option to add another square of exchanges to the blockchain. This expense additionally makes modifying the historical backdrop of the blockchain costly, bringing about virtual unchanging nature.

The blockchain insurgency has carried circulated data sets to the bleeding edge and may bring about more extensive selection and groundbreaking thoughts for their utilization. In any case, the advantages of disseminated data sets might be restricted to quite certain applications. And surprisingly with regards to these applications, while significant, it's anything but certain that appropriated information bases would bring considerable expense investment funds.

Current uses of blockchain have accumulated just restricted allure. Bitcoin's blockchain is the best, however even following 10 years Bitcoin has been embraced as an installment strategy just for explicit specialties. Standard clients frequently show that the current installment frameworks, like credit and check cards, fulfill their requirements, yet additionally offer types of assistance above what Bitcoin conveys. Blockchain advancements will probably altogether affect numerous enterprises, not simply finance. In any case, this may not occur in the way imagined.

2.8 Blockchain technology adoption strategies

(Joseph M. Woodside, Fred K. Augustine Jr, Will Giberson, 2017) in their study, “Blockchain technology adoption status and strategies” stated that Bitcoin have progressed and how blockchain can be used in enormous scope, endeavor conditions. Triangulation is used for this paper, which joins different techniques, like subjective and quantitative strategies, as integral parts for further developing examination study precision. The triangulation techniques picked for this paper incorporate an optional information climate examination, a book investigation, and monetary investigation to effectively oversee and survey the reception dispersion of creative innovations like blockchain. The blockchain stands to disturb numerous spaces of society with the legitimate application and along these lines analyze its utilization with however many perspectives as could be allowed.

The Diffusion of Innovation (DOI) hypothesis clarifies how a thought, item, or administration is received through a framework over the long haul. This appropriation of development happens at various rates inside individuals or those inside an association going from early trend-setters to late loafers. There are five significant classifications of adopters: pioneers, early adopters, early greater part, late greater part, and slow pokes. These five classes follow an ordinary appropriation, with the first 2.5% as pioneers to receive blockchain innovation, the second 13.5% are the early adopters, the third 34% are the early larger part, the fourth 34% are the late larger part, and lastly the fifth 16% are the loafers. The five classifications are fundamentally unrelated. Trend-setters are audacious to attempt innovation, have critical monetary support, and aptitude with innovation. Trend-setters energetically acknowledge expected disappointments and hazard while receiving innovation. Early adopters are normally incorporated in the nearby friendly framework and go about as through pioneers inside the neighborhood social framework dependent on past information.

Following are the key environmental factors of political, economic, social, and technical analyzed, with drivers and drawbacks of block chain technology categorized under the corresponding factor:

Political: Transparency (driver), regulatory status (drawback)

Economic: Costs (driver), volatility (drawback)

Social: User control (driver), Privacy and security (drawback)

Technical: Quality (driver), innovation (drawback).

Study restrictions remember an auxiliary information examination for political, financial, social and specialized variables, a comfort test of the best 50 biggest U.S. organizations by income with yearly reports for the content examination because of public availability, and monetary investigation dependent on cash dissemination.

Definitively, notably, the bookkeeping business stands to be hugely affected by the execution of block chain innovation via mechanizing large numbers of the manual cycles that make up most bookkeeping norms. For example, current monetary bookkeeping requires a twofold passage framework that is carefully examined for inside the public trust. While this framework guarantees exactness and certainty, it's anything but an extraordinary work and time cost and under current strategies almost difficult to mechanize. With the blockchain, organizations could record their exchanges straightforwardly into a joint register that makes a chain of bookkeeping records. With every exchange checked and a piece of the blockchain, changing or adulterating the recorded bookkeeping data would be almost outlandish. This implies that possibly all bookkeeping data could be checked electronically immediately, and license mechanized reviews with the normalization of the training. Fanatic adherents to block chain innovation excitedly lecture that the blockchain could be carried out in numerous authority limits past those as of now being used, for example, wellbeing records and in any event, casting a ballot. Blockchain, with its outrageous security and capacity to in a split-second check data, would appear to profit both of these spaces impeccably, however the current execution doesn't look good for these employments.

2.9 Comparative study on adoption of blockchain

(Franziska Wahl, 2018), A customer acceptance of new technology varies based on a variety of circumstances. Cultural influences appear to have a significant impact on consumer consumption behavior. As a result, it is critical for businesses to deal with their consumers in a variety of ways, depending on their culture, behavior, habits, motivation, and so on.

This study examines the influence of culture in affecting the behavioral intention to use bitcoins in four different nations, with a focus on blockchain technology adoption. To perform the research, the UTAUT2 model was applied to the case of bitcoin while taking cultural differences into account. Germany, the United States, South Korea, and Iceland were among the countries studied. The goal of this study was to use the Unified Theory of Acceptance and Use of Technology 2 to discover the characteristics that influence bitcoin currency adoption (UTAUT2). Understanding how culture influences the acceptance of new technologies is particularly fascinating.

The findings can assist firms that want to use bitcoin as an international payment option gains a better knowledge of how consumers in different cultures use the money. Despite the benefits of blockchains, there is the possibility of unlawful transactions. Dark enterprises are attracted to Bitcoins because of the great level of anonymity it provides to its clients. Although the blockchain keeps track of all customer transactions and prevents money from being spent twice, past research has shown how to design a worst-case scenario known as selfish mining. Despite the high level of assurance provided by the blockchain, selfish mining may be one reason why customers are hesitant to utilize digital currencies for their purchases, because the adoption of digital payment systems is based primarily on trustworthiness and security.

Consumer acceptance of new technology varies based on a variety of circumstances. Cultural influences appear to have a significant impact on consumer consumption behavior. As a result, it is critical for businesses to deal with their consumers in a variety of ways, depending on their culture, behavior, habits, motivation, and so on. This study examines the influence of culture in affecting the behavioral intention to use bitcoins in four different nations, with a focus on blockchain technology adoption. To perform the research, the UTAUT2 model was applied to the case of bitcoin while taking cultural differences into account.

Germany, the United States, South Korea, and Iceland were among the countries studied. (Hofstede (2001) and Cardon and Marshall (2008)) found uncertainty avoidance as the most influential cultural dimension on technology adoption, based on the cultural characteristics of individualism, power distance, uncertainty avoidance, and masculinity. The chosen countries were culturally diverse, but similar in terms of high technological development, which enabled them to achieve considerable results. Performance expectancy, effort expectancy, social influence, enabling conditions, hedonic motivation, price value, and habit are among the seven major characteristics of UTAUT2, which also contains three moderating variables: gender, age, and experience.

The UTAUT2 model was developed to include the variables of perceived risk and trust since consumers place a high value on security and reliability in terms of digital payment systems. Performance expectancy and culture, Effort expectancy and culture, social influence and culture, facilitating conditions and culture were used to create hypotheses. Motivation and culture of the hedonists, value for money and culture, culture and customs, trust and culture, as well as perceived risk and culture.

2.10 Socio economic factors behind blockchain adoption

(Francesco Parino, Mariano G. Beiró, 2018) in their study, stated that Bitcoin is a digital currency that was founded in 2009 as a banking system alternative. It not only provides a payment system that is decentralized (i.e., not controlled by institutions, governments, or banks), but it also introduces the innovative blockchain concept. All Bitcoin transactions are indeed recorded in the blockchain, a decentralized public database that is structured in blocks in chronological order and secured by powerful cryptography. Users can easily interact with the blockchain by using end-user software called Bitcoin clients to perform Bitcoin transactions (i.e. the transfer of Bitcoin value between identifiers of alphanumeric characters string).

Understanding the potential societal impact of a decentralized cryptocurrency based on blockchain technology requires a thorough examination of Bitcoin adoption. A significant portion of the effort is committed to the research and development of blockchain technology, as well as its application to other sectors. Another major area of study is the financial and economic issues, with one of the primary questions being the price evolution. Digital cryptocurrencies, such as Bitcoin, can have a huge social impact since they allow for quick and low-cost transactions, as well as a solution for tips, contributions, and micropayments without the use of a banking system, opening the path for widespread adoption. This impact is impossible to estimate, though, because users can generate as many Bitcoin addresses as they desire. Previous studies have employed either external data, such as the number of Bitcoin client software downloads by nation, the quantity of each fiat currency involved in Bitcoin transactions on exchange, or Bitcoin transaction data to investigate the societal impact of Bitcoin. Authors Proposed to use Bitcoin transaction data and external data sources to quantify Bitcoin adoption by country, highlighting the main elements that could function as a motivator or deterrent for Bitcoin adoption, and looking at how it has evolved over time. Furthermore, using specific metrics, the authors constructed and modeled an international Bitcoin flow network, from which they extracted socio-economic indexes related to transaction dynamics.

All Bitcoin transactions between Bitcoin addresses are stored in the blockchain database. The input and output Bitcoin addresses for each transaction were obtained. Furthermore, as the blockchain database expands by adding groups of transactions arranged in blocks, collecting the position of each transaction within the block as well as the block height (i.e. the number of blocks preceding a given block) becomes increasingly important. Bitcoin does, in fact, use a gossip system, in which users broadcast their new transactions to all their network peers.

To summarize, the blockchain infrastructure provided by cryptocurrencies such as Bitcoin is garnering interest from a wide range of industries, including trade, banking, government, and policy. However, quantifying this attractiveness and country adoption has proven to be a difficult undertaking. This study investigated the primary variables that led to the adoption of Bitcoin as the first blockchain technology in several countries. Different strategies for deanonymizing and geolocating the users were used.

It was also demonstrated that the number of IP addresses associated with transaction relay nodes, the number of Bitcoin client downloads, and google trends interest all provide a consistent picture of user adoption by country, even though each of them only provides a partial view of the Bitcoin system. Bitcoin acceptance has not been uniform over the world: it has grown rapidly in many rich countries since its inception, while it has grown slowly in developing countries.

2.11 Blockchain tradeoffs and challenges

(Carl Worley, Anthony Skjellum, 2018) in their research covered several existing and future Merged mining, fragmentation, the network effect, scalability, and generalized blockchain techniques, as well as tradeoffs in the design and implementation of blockchain systems that aim to give universal functionality. In many elements of the existing limits, Bitcoin, Ethereum, Cardano, and Rootstock are considered, as well as potential future remedies to difficulties.

The prospects of success of several generalized blockchain paradigms, including network effect scalability and future client-side use, are weighed in this article. The authors argue that the network effect favors a Bitcoin/side chain solution over a direct Ethereum solution due to scalability. The chances of any single decentralized application gaining widespread adoption appear to favor an Ethereum solution. Scalability is soon becoming a barrier for blockchains, requiring a fundamental redesign of old blockchain protocols to achieve scalability, and the Ethereum Foundation development team appears to be the only one with a long-term plan to handle it now. Ethereum plans to switch to a proof-of-stake mining method that is faster than proof-of-work, as well as sharding, which will allow the blockchain to be split into several "universes" yet still converge on a shared consensus. If Bitcoin introduces an SPV proof operation, side chains will be a stronger rival (a feature that allows side chains).

Because Bitcoin is Turing-incomplete, it cannot satisfy any use case that involves looping or recursion. As a result, additional blockchains will be required to suit a variety of use cases. A strong solution is to employ an application-specific blockchain, which allows the blockchain to be adapted particularly to the application in mind. Everything from the block's data structure to the mechanism for mining additional blocks can be set collectively.

The following are a few instances of such blockchains:

Litecoin: Litecoin's proof-of-work algorithm is the memory-hard scrypt method, as contrast to Bitcoin's easily parallelizable SHA-256 algorithm. Because memory-hard algorithms are more difficult to construct expensive specialized hardware for, centralization of mining—the concentration of processing power in the hands of a few network participants—is less possible. Litecoin also has an average block mining interval of 2.5 minutes, as opposed to Bitcoin’s 10-minute block time, in order to make transactions verify faster.

Namecoin: Namecoin is a blockchain-based domain name resolving technology. It's a database of entries that may be bought with Namecoin's token. Unless renewed, these records are valid for a fixed number of blocks. Any identification information, such as public keys or domain names, can be stored in them.

Certcoin: Based on Bitcoin and Namecoin, Certcoin presents a decentralized alternative public key infrastructure. The concept employs two key pairs: an online key pair for authentication and encryption, and an offline key pair for revoking and updating the online key pair in the event of a key compromise. Certcoin credentials are used to secure communication between a client and a server, and the domain is registered on the Namecoin blockchain.

Scrybe: Scrybe is a provenance system based on the blockchain. It has blocks with a field where any W3C PROV-compliant metadata can be stored. The mining system employs a revolutionary lightweight mining procedure that determines which miner gets the permission to construct the next block without using the resources required by proof-of-work algorithms.

A specified miner set is required for this mining technique. The various methods presented so far may be considered as rivals because the fragmentation problem stimulates the adoption of a unified standard for generalized blockchains. Although it is impossible to predict the future, there are three identified characteristics that may influence these systems' future success: the network effect, scalability, and the first killer dapp. Because a substantial portion of a platform's value derives from networking with other users, the "network effect" states that systems with more users will tend to gain more users faster than systems with fewer users. Due to the requirement that all nodes validate all transactions (which necessitates a complete copy of the blockchain history), scalability has become one of the most pressing concerns with blockchains, even in their current limited market. If widespread adoption is ever reached, whichever blockchain is able to solve the scalability problem will most likely be the market leader.

The purpose of generalized blockchains is to create decentralized applications, generally known as "dapps." Whichever blockchain creates the first "killer dapp2" that gains widespread adoption may garner enough users to win market dominance. The most obvious dapp is decentralized payments, which most blockchains allow natively. Ethereum is the only blockchain where a substantial number of dapps are actively being developed, as it is the only smart-contract platform that is now operational. To summarize, since 2009, there has been an explosion of cryptocurrency technologies aimed at achieving diverse purposes. However, mining numerous blockchains independently generates a fragmentation problem, which reduces the security of each blockchain. This article looked at how to generalize blockchain technology so that it can be used in a variety of settings without sacrificing security. One possibility proposed here are side chains with merged mining; however, they are currently hard to deploy without a change to the Bitcoin protocol and may be impossible to implement without trusting miners. Authors proposed protocol-level general blockchain as a replacement for that solution.

2.12 Blockchain beyond Bitcoin

(Michael Crosby, Pradhan Pattanayak, Sanjeev Verma, 2015) in their research, “Blockchain Technology Beyond Bitcoin”, stated that Every transaction ever made is recorded in the blockchain, which is certain and provable. The most well-known example of blockchain technology is Bitcoin, a decentralized peer-to-peer digital currency. Although the digital currency bitcoin is divisive, the blockchain technology that underpins it has performed well and has a wide range of uses in both financial and nonfinancial sectors. The basic idea is that the blockchain creates a distributed consensus system in the digital online world. By producing an irrefutable record in a public ledger, involved entities can be assured that a digital event occurred. It paves the way for a democratic, open, and scalable digital economy to emerge from a centralized one.

The blockchain technology is described in this white paper, as well as some intriguing specific applications in the financial and non-financial sectors. Bitcoin is the most well-known example of a cryptocurrency that is inextricably linked to blockchain technology. It is also the most contentious since it contributes to the creation of a multibillion-dollar worldwide industry of anonymous transactions that is free of official regulation.

As a result, it is responsible for a variety of regulatory concerns involving national governments and financial institutions. The benefits of Blockchain technology outweigh the technological and regulatory challenges. Smart contracts are a crucial emergent use case for blockchain technology. Smart contracts are computer systems that can automatically carry out a contract's terms. Blockchain technology is being used in a variety of fields, both financial and non-financial. It is no longer viewed as a threat to existing business models by financial organizations and banks. In fact, the world's largest banks are researching creative blockchain applications to see if there are any potential in this sector. Opportunities for non-financial applications are also available.

The blockchain might be used to verify the existence of all legal documents, health data, and loyalty payments in the music industry, as well as notaries, private securities, and marriage licenses. The anonymity or privacy goal can be achieved by storing the fingerprint of the digital asset rather than the digital asset itself. Contracts that are automatically enforced by computer protocols are known as smart contracts. Smart contracts are now easier to register, verify, and execute thanks to blockchain technology. Blockchain-based smart contracts are being enabled by open-source firms such as Ethereum and Codius. Smart contracts are supported by many organizations that use bitcoin and blockchain technology.

Ethereum's programmable platform characteristics have sparked a lot of interest. Anyone can develop their own coin and use it to execute and pay for smart contracts on Ethereum. Ethereum features its own coin (ether) that can be used to pay for services. Governance, autonomous banking, keyless access, crowd funding, financial derivatives trading, and settlement utilizing smart contracts are just a few of the early applications powered by Ethereum.

Industry is currently pursuing three techniques to accommodate alternative applications and overcome perceived limits of the Bitcoin blockchain:

Alternative blockchains: This is a method of achieving distributed consensus on a digital asset using the blockchain algorithm. Merged mining occurs when they share miners with a parent network, such as Bitcoin's. It has been recommended that they incorporate DNS, SSL certification authority, file storage, and voting applications.

Colored Coins: It is an open-source protocol that defines a set of mechanisms for developers to generate digital assets on top of the Bitcoin blockchain by extending its functionality beyond that of digital currency.

Sidechains: These are alternate blockchains backed by Bitcoins via Bitcoin contracts, like how dollars and pounds were backed by gold in the past. There might be thousands of side chains "pegged" to Bitcoin, each with its own traits and objectives, all taking use of the Bitcoin blockchain's scarcity and resilience. Once the experimental side chains have been tried and tested, the Bitcoin network can iterate to support further functionality. There are considerable dangers of adoption with radical inventions, such as behavior change, scaling, bootstrapping, government regulations, fraudulent activities, and quantum computing.

To summarize, blockchain is the technology that underpins Bitcoin. Blockchain's distributed ledger feature, combined with its security, makes it a particularly appealing technology for solving existing financial and non-financial business concerns. In terms of technology, cryptocurrency-based technology is either on the decline due to exaggerated expectations or in the trough due to disillusionment.

There is a lot of interest in blockchain-based commercial applications; hence there are a lot of startups developing them. As previously said, the adoption confronts a significant headwind. Large financial companies like as Visa, Mastercard, Banks, NASDAQ, and others are investing in the study of how current business models might be applied to blockchain. In the realm of blockchain, some of them are looking for new business models. Some people want to be ahead of the curve when it comes to blockchain regulation changes.

2.13 Dynamics of blockchain implementation

(Simon Albrecht, Stefan Reichert, Jan Schmid, 2018) stated in their research, "Dynamics of blockchain implementation – A Case Study from the Energy Sector", the impact of theory-based considerations on the implementation of different blockchain technology in use cases from the energy sector. Based on the Diffusion of Innovations theory, institutional economics, and the technology-organization-environment framework, the authors developed an integrated research model.

The authors link dimensions to theory and examine their impact on each use case using qualitative data from in-depth interviews. The rise of renewable energy, Distributed Energy Resources (DER), and smart grids has resulted in the creation of a network in which many devices may automatically connect with one another. Regardless of the hype, blockchain's potential in the energy sector appears to be promising. Process automation, disintermediation, and value chain rethinking provide degrees of flexibility for creative applications and business models. Technological and socioeconomic advances are causing changes in the energy markets.

Traditional thermal power plants are being phased out in favor of distributed energy supplies. This causes supply to fluctuate, raising uncertainty. The energy economy is becoming increasingly complicated. In addition, analogue meters are being phased out in favor of smart meter gateway connected devices. High volatility is caused by heterogeneous generation. As a result, there is a lot of uncertainty about supply and price. Residents and local organizers are becoming more interested in DER such as power-heat coupling plants, photovoltaic installations, and biogas facilities. A growing portion of energy demand may be met locally, making grid balancing a difficult undertaking.

Customers' engagement and empowerment are increased as the energy market develops, allowing them to optimize household consumption and switch retailers. Relationships having strong impacts are classified as follows based on qualitative data:

Microgrids and local residential p2p-trade: The regulatory environment, according to the authors, is a major problem for microgrids. Most governments prohibit residential P2P trading, which is only possible in the BMG by incorporating LO3 as a licensed utility. Because transactions can be completed without the involvement of a third party, blockchains eliminate the necessity for middlemen.

Grid services: The growing number of DER with variable generation puts existing grid monitoring and balancing systems to the test. Monitoring the grid's condition and adopting stability actions necessitates high-integrity data that is constantly and in near-real-time available to a restricted number of participants.

Wholesale electricity markets: Blockchains allow for direct electricity trade without the use of middlemen. Using the Tendermint consensus mechanism for permissioned blockchains, the Ponton Enerchain platform currently enables wholesale trade for two dozen European utilities. A permissionless blockchain may be preferred only when a suitable scaling mechanism, such as that employed in multifunctional chains, can establish a critical mass of members.

Asset management: Blockchains can be used to coordinate the monitoring, metering, and documentation of specific energy resources. Engineers and investors will be able to access information on ownership structures, load profiles, and maintenance status in this manner.

Certification of green electricity: To trade renewable energy certificates, renewable power plants must often be approved by various institutions through time-consuming processes. Typically, residential customers do not receive accurate information on their real green energy usage. A ledger for green energy certificates must be based on trustworthy data that is accessible to stakeholders and public. While both permissionless and permissioned blockchains can provide information transparency, the latter system has the potential to ignore immutability and hence data integrity by removing transaction history.

E-mobility charging infrastructure: The infrastructure of electric vehicle charging stations is defined by a large number of different providers, each with their own invoicing and accounting systems. A blockchain charging infrastructure with over 1200 stations, partly owned by private individuals, is now operated by share & charge, a spin-off formed within the innovation cluster. E-mobility necessitates a system in which unknown nodes can carry out spontaneous transactions without prior identification, in addition to the confidentiality of personal location data and the capability to safeguard charges at any moment.

To summarize, the authors explored how and by what aspects the application of blockchain technologies in energy sector use cases is influenced. Power-induced factors and technological constraints have an impact on both grid services and microgrids. Permissioned blockchains exhibit properties that correspond to these factors, appropriating a system controlled by a few numbers of stakeholders. The wholesale electricity market has substantial ties to technological constraints, but it has minimal ties to power-induced and network-related issues.

Because the effects are in opposite directions, either permissioned or scaled permissionless solutions may be appropriate for a specific project. Trust-supplementing variables affect asset management and green electricity certification, suggesting a system with reliable data and potentially reading access for many entities. Network-related elements that imply a demand for open and interoperable systems, such as multi-purpose chains, have a significant impact on e-mobility charging infrastructure. The research sheds light on elements that affect the development of blockchain use cases as well as the design of economic and political institutions to oversee blockchain technology regulation.

2.14 Factors affecting blockchain technology diffusion

(Ruben Post, Koen Smit, Martijn Zoet, 2018) stated in their research that, blockchain technology is gaining traction among academics and practitioners alike, and it has the potential to disrupt established labor techniques in a variety of industries. At least, that's what early adopters and inventors have promised. However, it has yet to make an impact on our culture, whether through organizational use or other initiatives such as cryptocurrency. Many people have urged for more funding to help blockchain technology spread faster. Despite this, just a few businesses have used blockchain technology. By interviewing blockchain technology specialists, the goal of this study is to uncover these aspects.

Due to the maturity of the research domain, these experts were interviewed via semi-structured interviews. This research intends to enlighten and address practitioners and the academic community about these characteristics in addition to identifying them. The current condition of the research field provides information about previous study and is used to guide future research. According to a review of the literature on blockchain technology, many contributions are focused on the technical aspects of the platform. A semi-structured interview strategy was used to collect data for this study.

The snowball sampling method was used to choose the participants. During the interviews, participants were asked to name the industry they believe will be most influenced by blockchain technology, as well as potential players from that area. The interview with the referenced participant(s) (if applicable) in the named industry was then scheduled. The first participant was chosen based on their present and former jobs, as well as their estimated expertise of blockchain technology.

Based on the data gathering and analysis, the following is a summary of the identified factors affecting blockchain technology diffusion:

Factors at strategic level:

Necessary collaboration: There are two sub-factors in this factor: There are two types of collaboration: 1) external collaboration and 2) internal collaboration. Collaboration with other organizations is referred to as external collaboration. Businesses must align their business processes, data models, and decision-making processes. They should form a coalition of autonomous organizations that use a variety of coordination techniques to seem like a single entity. Internal collaboration refers to the organization's internal business and IT alignment. Before contact with exterior competing entities can begin, there must be some level of collaboration between these entities.

Necessary paradigm shift: A paradigm is a manner of thinking in general. Currently, most IT departments adhere to an introvert mentality. Employees must adapt mindsets in addition to the way firms operate. Currently, technology is designed to keep others out. Others must be included in this design, rather than being treated as subordinates, clients, or users. This necessitates a whole different mindset. Blockchain technology, on the other hand, supports this paradigm by removing the requirement for trust in the required paradigm.

Market position adoption: This factor has two sub-factors: 1) Market function adoption and 2) Revenue model adoption.

Organizations may need to take a different market position, according to nine panelists. The movement in an organization's market position is referred to as market position adoption. To generate revenue, some businesses rely only on an intermediary function. When blockchain technology is introduced into the relevant sector, this function may be mitigated. To stay successful, these businesses will have to develop new revenue streams.

Compliance: Compliance imposes several restrictions on blockchain technology applications. Being compliant entails adhering to a set of (at times) inflexible norms.

Sector pressure: Sector pressure refers to the pressure organizations are sensing from competing entities.

Organizational size: This factor has two sub-factors: 1) Too much complexity and 2) Lack of capacity. Because of the required collaboration and coordination, it is more difficult for a company to integrate blockchain technology into its business operations when its structure, IT systems, and decision-making are complicated.

Factors at tactical level

Knowledge deficit: This factor has three sub-factors: 1) Lack of available knowledge, 2) Lack of blockchain curricula, and 3) Lack of domain and technical knowledge

Viable use cases: This factor has two sub-factors: 1) Uncertain forward outlook and 2) Solution-before-problem thinking. Situations, processes, or applications in which blockchain technology can be employed are known as use cases. The inability to establish feasible use cases is due to a lack of imagination and understanding.

Implementation method

Change readiness: Change readiness is defined as the attitude of an individual towards the acceptance of a certain change.

Factors at operational level

Technical shortcoming: This factor has three sub-factors: 1) Adequate data model, 2) Need for standardization, and 3) Supportive tooling.

Process maturity: Blockchain technology necessitates a consistent data model as well as the digitization of some data. The implementation of blockchain technology will be hampered if an organization's process maturity is insufficient.

Finally, from a practical standpoint, the factors affecting blockchain technology dissemination are useful. The considerations could be used as guidance in the future when implementing or exploring blockchain technology.

2.15 Modeling and simulation of blockchain

(Navneet Kaur Bajwa, 2018) in his study stated that blockchain is a brand-new technology that has the potential to transform the future of transaction-based marketplaces. To use this technology in numerous domains, much research is being conducted. Blockchain technology has the advantage of built-in auditability, trust, and value transfer, which makes it enticing. Through mathematical modeling and simulation techniques, this work investigates an agent-based blockchain based education system.

The model is designed to look into how blockchain technology might be used to verify student credit scores, as well as identify and avoid potential attacks. Cost, duration, and behavioral considerations of the system are also made, in addition to technological aspects of Bitcoin and blockchain. The number of transactions, blockchain size, network efficiency, and cost analysis of the system, as well as network efficiency, are then examined. The proposed model, which is based on blockchain technology, transforms the analogue and physical grading and credit-rewarding system into a globally efficient, transparent, and universal version. The work lays a foundation for furthering existing understanding of blockchain systems and the development of blockchain simulation models.

This work goes a step farther by addressing the following three research gaps:

- The most critical feature of any distributed ledger system: trust, was considered while undertaking mathematical modeling. This is done to improve the system's security and prevent attacks.
- To address the second research gap, in addition to technical qualities, additional system aspects such as cost, time, and system behavior under assault are also modeled.
- Finally, for the blockchain-based education system, a preferential network structure is modeled.

A proof-of-concept model was created to show how an education institute blockchain may be used in a hypothetical system with three agent groups: administration, professors, and students. By leveraging a hypothetical blockchain with a native coin - tokens – all participants in the system can access relevant data in a dispersed manner.

Netlogo modeling software, which uses the Java computer language, was used to create the model. To ensure consensus, the architecture comprises a cryptographic peer-to-peer ledger with a very rudimentary mining mechanism. Each participant has their own public key, a copy of the blockchain data, and a set of local records. Transactions can be initiated, stored in a memory pool, shared, and added to the blockchain, verified and validated, and finally included to a new block. Because it only includes the dynamic position of entries, rather than the entire record, this design lowers the amount of data kept in the public blockchain. The model also includes functionality that allows any participant to create a verifiable entire history of any other participant's data using only the participant's public key.

The model illustrates the auditability, availability, universality, and reconciliation of these distributed student records throughout the blockchain network. A system like this might also help to eliminate fraud, cut expenses, encourage student engagement, and enhance the overall system. The most significant aspect of a decentralized network is that the trust function is considered when undertaking mathematical modeling to improve the security of such a system and avoid attack.

2.16 Organizational adoption of blockchain technology

According to (Holotiuk, Friedrich and Moormann, Jürgen, 2018), the rise of blockchain technology shows the disruptive influence of digital innovation while also posing problems to businesses. As a result, organizations are in the process of supporting organizational adoption. This level of acceptance is represented in far-reaching technological, organizational, and human indicators. The measures are governed by project management, which aligns internal and external measures. The research builds on an empirical study to investigate the organizational adoption of blockchain technology using this paradigm. Different aspects, such as structure, methods, and mindsets, are encapsulated by the framework's four dimensions - technology, organization, people, and project management. Firms can change their organizational structure by developing transformation strategies, technology assessment plans, and innovation cultures based on these characteristics. The term technology in the proposed framework refers to the blockchain technology itself, as well as several variables that surround it. Some of these aspects, such as the technology's capabilities, the system's adaptability, and the gap between the technology and the organization, have been studied in the context of other technologies.

The purpose of organizational adoption is to identify the best fit between technology and the organization; as a result, businesses seek out the most appropriate configuration of technology to guarantee that technology meets their specific needs. Organizations assess numerous characteristics such as the technologies' maturity, robustness, dependability, and timeliness "to maximize the possibility of selecting the proper system," as has been found with other technologies of similar scope, such as Enterprise Resource Planning (ERP) systems. The organization, like technology, has various aspects that influence organizational adoption. In order for an organization to accept a new technology, it must undergo organizational changes, such as altered business procedures.

Like technological modifications, the organization must adapt to better its compatibility with new technologies such as blockchain. Organizations must enable open innovation processes that equally exploit the interchange between departments, as well as across organizations, because blockchain is a technology that leverages its potential in a network with numerous partners. People within the organization, in addition to technology and organization, are influencing elements in the firm's adoption of blockchain. An organization's people take actions that lead to organizational adoption. People require specific talents to carry out their responsibilities, and hence suitable skills are required. New abilities are necessary when a new technology is introduced.

The goal of the activities is to familiarize individuals with new technology and strengthen its integration into the organization. Project management allows for control of the three aspects – technology, organization, and people – and guarantees that they are aligned for organizational adoption success. To accomplish so, roles and responsibilities must be clearly defined, as well as the project's leadership. Challenges must be identified, and appropriate actions must be taken. Tasks must be allocated throughout corporate functions, and individuals must be encouraged to participate in the organizational adoption effort. To eliminate any (potential) friction between technologies, organizations, and people, project management must ensure a smooth interplay of the three dimensions, which includes providing feedback and establishing the correct balance between top-down and bottom-up management. The environment is a well-established aspect of organizational adoption, and it's closely linked to a lot of TOE-based adoption studies.

2.17 Issues hindering blockchain adoption

The goal of (Karol Gusak's , 2018) study was to identify and explore the most pressing concerns with blockchain and blockchain-related technology that could stymie its adoption. To identify and assess concerns in usability, security, scalability, regulations, and other important areas, literature research was conducted. The obtained data, which were examined using the thematic analysis method, indicated the most experienced concerns, validating many conclusions from the existing literature while offering a more up to date knowledge of others.

The goal of this study was to check the challenges in blockchain from the views of end users and professionals participating in the development of blockchain-related software, and to ensure that the two groups' perspectives were aligned. Users and professionals involved in the development of various blockchains and blockchain-related technologies collaborated on the study.

According to (Klein and Myers, 1999), the interpretative paradigm is useful for research that aims to comprehend phenomena by investigating its social construct. The philosophy of understanding rather than prediction, according to Boland (1991), is best suited for a field with minimal preceding study and theoretical development. According to Creswell (2014), the occurrences are observed and evaluated by the researcher, and hence are subjective, with no guarantee of repetition. Qualitative research focuses on the examination and description of the observable social context, allowing for in-depth analysis and comprehension of systems from the users' perspective. Interviews were used in the data collection process. Because the interviews were conducted over the phone, the participants' geographical location is unknown.

The reason for this is that the participants' organizations are often dispersed, with personnel from all over the world. The majority of blockchain projects are open source, and participants engage openly through online discussion boards and collaboration tools. Although the findings of this investigation may appear pessimistic, with numerous issues confirmed as still being present in blockchains, it was encouraging from the developers' perspective that they appear to be on top of the current situation and on track with their development efforts, as confirmed. From a theoretical standpoint, the research has corroborated most of the challenges raised in the literature, such as high entry barriers for users, which are exacerbated in part by usability issues, as well as security, privacy, and centralization concerns.

Furthermore, it has revealed that most users accept usability concerns with blockchain-based products and recognize that they are caused by the security principles integrated in blockchain design. From a practical standpoint, the findings of this study reveal that, contrary to what developers' comments appear to suggest, blockchain users are reasonably smart and tech savvy. Also, the findings on sustainability show that worldwide adoption of blockchain in its current form may be impossible, as the network would require a significant amount of energy just to operate. It also implies that blockchains do not require widespread acceptance to have a big impact on numerous sectors of the global economy, owing to the benefits they provide in specialist applications such as logistics. Alternative solutions to the sustainability problem are also being developed, with the goal of replacing the Proof of Work algorithm with a more sustainable one, albeit the findings show that users are unaware of the efforts.

2.18 Tracing and tracking with blockchain

(Giovanni Miragliotta, 2019) focuses on the possible impacts of blockchain technology adoption on supply chain management and all operations associated with a company's manufacturing process. In essence, the blockchain revolutionizes the current method of online data transfer since the activity of verifying and validating the accuracy of transactions is no longer carried out by a central authority, but rather by the network's participants.

This means that the transaction is carried out directly between the sender and the receiver, without the use of a third party and, as a result, without the payment of any intermediary fees. The validity of transactions is confirmed when transactions are verified by many network members. There are various types of consensus algorithms with different characteristics, but in general, the validity of transactions is confirmed when transactions are verified by most network members.

Validator nodes, members of the blockchain who provide their CPU power to the mining activity, are known as miners and are reimbursed by the system. Transactions approved by the blockchain are permanently recorded on the blockchain's distributed shared ledger and cannot be changed by anyone. Indeed, the decentralized ledger implies that data is no longer stored in a central system, but rather on all nodes, implying that a rogue node would need to control most the network's CPU power to change the ledger.

The regulation of transactions is one of the major roadblocks to the scalability of blockchain technology. In fact, governments have yet to intervene to write a legal code for blockchain transactions; as a result, despite the clear potential of this technology's application, blockchain is sometimes viewed as something outside of the traditional channels for moving cash, assets, and information, and as a result, it is viewed as risky and unreliable by businesses.

Supply chain planning entails making strategic, tactical, and operational decisions throughout the supply chain, from procurement to distribution, in order to meet the company's objectives. The basic goal of planning is to meet demand in order to maximize revenue while also aligning demand and supply to save expenses. Transparency of supply and demand information is essential for successful supply networks. Supply chain actors can employ technology to track stock as it flows in and out of warehouses. The ability to track and trace things throughout the supply chain is consequently critical to supply chain management. Tracking is the capacity to locate a specific product wherever it is in the supply chain so that it can be withdrawn or recalled as needed.

Because the network controls the authenticity of transactions, blockchain technology allows participants to create a distributed shared ledger among members of the same network, allowing them to perform on-line transactions without the need for an intermediary. The technology represents a new form of trust, one that is less reliant on a central authority and more democratically based on the control of each network node. The ledger is not owned by anyone, but it is open to any user who can download it and control transaction information; no transaction can be changed once it has been registered on the block chain, and the system tracks every item moved.

Three major benefits of using blockchain for supply chain traceability may be identified:

1. Non localization: Each user has access to the system's current state without having to go via a single authority, if they follow the same set of rules.

2. Security: The blockchain ledger is not stored on a central server; instead, it is distributed among all nodes, with each node having a copy. As a result, attacking one node is insufficient to change data in the ledger because the other nodes quickly detect the hacker assault and do not validate the newly updated database.

3. **Auditability**: Because each transaction is recorded on the chain, the blockchain ledger is easily auditable. Instead, because transaction data often comes from a range of sources, auditing in centralized systems can take a long time and cost a lot of money.

After examining the characteristics of blockchain technology and pilot projects involving its application in supply chain management, it is feasible to gain a better understanding of the blockchain's potential. It may be possible in the future to have products talk to customers about their origins without the risk of data manipulation. As a result, supply chains will become transparent not just to customers, but also to legal authorities, who will be able to readily monitor the legality of business operations.

Furthermore, the blockchain will benefit businesses by providing a real-time tracking system that will allow businesses to have continuous information about the state of their products, allowing them to improve all aspects of their supply chain management, from contract signing with customers/suppliers to planning activities, quality control, and reverse logistics.

Furthermore, this effort seeks to serve as a springboard for future research in the field, as well as provide basic knowledge to anyone interested in the topic and trying out different ways to use blockchain technology to improve supply chain management in other industries. The adoption of blockchain technology in the chocolate sector was advocated during this study, but future research may be conducted to identify new companies in new industries where pilot projects in tracking items with the blockchain could be implemented.

2.19 Maturity model for blockchain adoption

(Huaiqing Wang, Kun Chen and Dongming Xu, 2016) proposes a maturity evaluation taxonomy that will be utilized to construct a blockchain maturity model (BCMM). In addition, this research proposes a technique that aids businesses in the creation and deployment of blockchain applications. Blockchain technology allows for the development of democratic, open, and scalable digital economies. Superior features such as smart contracts and smart property are among the qualities of blockchain technology.

Private securities, insurance, Internet finance, and other financial applications are possible, while non-financial uses include the Internet of Things, decentralized data storage, notary documents, anti-counterfeit solutions, and so on. Measuring the maturity of a blockchain system is problematic for the technology's adoption because "you can't manage it if you can't measure it." An organization's present status of the product is assessed before it is included in a strategic plan, which is a common business technique for building and adopting a blockchain application. For a long time, maturity modeling has been used in the field of information technology. The most prominent model, the capability maturity model (CMM), was initially used to assess the degree of software development processes.

According to the ACM Computing Classification System, technology maturity is defined by four indicators: networks, information systems, computing techniques, and security and privacy. According to the ACM Computing Classification System, technology maturity is defined by four indicators: networks, information systems, computing techniques, and security and privacy.

To determine the maturity level of the BCMM, authors adapted the five stages (stage 1 to stage 5) of maturity from CMM: (1) initial, which is the chaotic and ad hoc status of a new service; (2) repeatable, wherein some experiences are borrowed from similar products; (3) defined, which is the stage at which a service is standard and documented; (4) managed stage, which comprises the standard metrics proposed for qualitative evaluation; and (5) optimizing, which means that the service is continuously optimized and improved.

BCMM contains four CSS categories as described below:

1) In the network category, the biggest concern in blockchain adoption is the network loading problem because each transaction is broadcasted over the network.
    - *Architecture*: It's unclear whether the system is built on the public Internet or a private intranet. Because the blockchain system may not be a stand-alone system, integration with existing information systems is difficult.
    - *Upgrading*: Environment changes (e.g., Internet communication protocols, computer operating systems, programming languages, interfaces, and external databases), bug corrections, and improvements all necessitate blockchain system upgrades.
    - *Integration:* In many cases, the blockchain system is a sub-system of an organizational information system rather than a stand-alone system. As a result, there are two demanding integration jobs to do. To begin with, integrating prior transactions into the blockchain system is a time-consuming process. Second, the blockchain system must be integrated with older systems through the organizational system.
    - *Storage:* Each block is replicated and stored in the hands of numerous parties. Such massive duplications are inefficient in terms of storage.
2) In the information systems category, the maturity level of most features of blockchain is lower.
    - *Scalability:* Extending blockchain systems and estimating the costs of such upgrades is difficult.
    - *Maintenance:* There is no other blockchain system in the actual world besides Bitcoin. As a result, there is a scarcity of maintenance experience.
    - *Business efficiency:* Blockchain systems can perform trusted transaction storage and are more efficient than the traditional approaches.
3) In the computing methodologies category, most features of blockchain have not yet achieved high-level maturity.

- *Standardization:* Now, blockchain standardization is in its infancy. It is necessary to establish an institution to oversee and develop such standards.
- *Computational complexity:* All computations are carried out by all the parties involved. In terms of complexity, such an approach is not deemed efficient.

4) In the privacy and security category, the blockchain technology is rated well.

A safe adoption procedure comprising three stages is described below:
Feasibility study: Why blockchain? If four or more of the following conditions are met, then blockchain has strong potential to provide a solution:

1) Multiple parties share data: multiple participants need views of common information
2) Multiple parties update data: multiple participants take actions that need to be recorded and change the data
3) Requirement for verification: participants need to trust the validity of the actions that are recorded
4) Intermediaries add cost and complexity: removal of ‘central authority’ record keeper intermediaries has the potential to reduce cost (e.g., fees) and complexity (e.g., multiple reconciliations)

To summarize, blockchain is a promising breakthrough technology that has a wide range of applications. However, actual information demonstrating a comparison between blockchain and traditional methodologies is currently difficult to come by. In terms of acceptance, enterprises should be aware that the blockchain system is still in its early stages of development and should do significant feasibility studies before implementing it.

2.20 Blockchain versus database: A critical analysis

(Mohammad Jabed Morshed Chowdhury, Alan Colman, et al, 2018) in their research, “Blockchain versus Database: A Critical Analysis”, states that, this technology is also known as "Scattered Ledger Technology" since the data is kept in distributed nodes. This study provide a critical assessment of both technologies based on a review of the research literature in which blockchain solutions are used in a variety of scenarios. This Study built a decision tree diagram based on this study to assist practitioners and researchers in selecting the suitable technology for their use cases.

The survey highlights the contrasts between blockchain technology and the Central Database system in terms of trust building, data confidentiality, robustness/fault tolerance, performance, redundancy, and security. It has been discovered that blockchain may run without a trusted party based on trust building, but central databases require a central trusted party. Based on data confidentiality, in blockchain, all nodes have access to the data, whereas in a central database, access is limited to authorized individuals. In blockchain, data is dispersed among nodes based on robustness/fault tolerance.

The data in the central database is saved in the central database. According to performance, reaching consensus on blockchain takes time (e.g., 10 mins for Bitcoin). Immediate execution/update is possible in a central database. In terms of redundancy, each participating node in a blockchain has the most recent copy, whereas only the central party has a copy in a central database. Blockchain uses cryptographic techniques to meet security constraints, whereas a central database uses traditional access control.

In general, blockchain technology is beneficial in situations where there are multiple administrative authorities and a lack of confidence between them. A supply chain management system, for example, is a system in which several parties work together to provide items. Another example would be a group of independent enterprises cooperating on a government project where the parties have a trust gap. When there is a trust gap between the collaborative partners, they frequently choose a trusted third party who is trusted by both parties. For example, both the buyer and the seller rely on the bank to conduct their financial transactions. Finding a trustworthy third party, on the other hand, can be difficult and risky at times. Also, if the recorded value in the blockchain needs to be publicly verifiable, we should choose a public blockchain; however, if the data is only for a few parties, a private blockchain is a better option because consensus processes can be simplified.

Blockchain has shown to be a useful tool for supply chain management. Another possible area for blockchain implementation is home-based renewable energy generating and distribution management systems. Smart home situations are a good example of how blockchain may be misused. To begin with, smart home is a private network that rarely has any concerns with trust. The blockchain's immutability and decentralization are also irrelevant in smart home applications. Finally, it is discovered that if the system's priorities are trust building, resilience, and data provenance, then blockchain is the best choice. If the key concerns are confidentiality and performance, a traditional database is still the superior option. The authors also offered a decision tree to help evaluate the appropriate usage of blockchain (vs. database technology) based on the features of the problem, with the goal of preventing blockchain misapplications and failed system implementations.

2.21 Trust, and its effect on blockchain

(Jane Seppala et al, 2016) explains the strategic knowledge of blockchain technology by giving a framework for evaluating use cases and demonstrating how blockchain may be used to boost trust or eliminate the need for it in a transaction. Second, this research has ramifications for both businesses and subsequent research, demonstrating that blockchain use cases are difficult to come by. Furthermore, the function of trust in a sector appears to influence the types of improvements that blockchain can bring to company models. As a result, blockchain technology can be classified as both a technological and a business model breakthrough and distinguishing between the two is critical. Blockchain, as a business model innovation, has the potential to disrupt company models across a wide range of industries and geographical locations.

Everyone is familiar with the definition of trust, which is some type of reliance on another person or thing that is beyond one's control. Risk and interdependence are two prerequisites for trust. Interdependence between the trustor and the trustee is required. If the trustor is not reliant on the trustee's conduct, trust is unnecessary because their actions, however unpredictable they may be, have no bearing on our well-being.

However, if there is no uncertainty in this interdependency, there can be no trust because the trustee's actions cannot alter the path of events.

In terms of, say, purpose or realm of action, trust has a range. Because trust is two-sided and asymmetric, it must be created both ways when it is required. We can trust objects, processes, or computer algorithms, and the recipient of our trust does not have to be a person. How and when we trust something is limited by the breadth of trust. Trust is a psychological state that develops under risk and reliance. It is an underlying psychological condition rather than a behavior.

Two definitions that are frequently referenced are unwavering quality trust and choice trust. Dependability trust can be characterized as "Trust is the emotional likelihood by which an individual, A, anticipates that another individual, B, plays out a given activity on which its government assistance depends." "Choice trust changes as a component of the utility qualities related with the conceivable game-plan", suggesting that the setting is significant not just identifying with the unique situation or extent of activity yet in addition from a bigger perspective.

Business transactions require a high level of trust. There are relatively few transactions in which the parties do not need to trust one other. The inefficiencies induced by knowledge asymmetry are mitigated by trust. Business transactions require a high level of trust. There are relatively few transactions in which the parties do not need to trust one other. The inefficiencies induced by knowledge asymmetry are mitigated by trust. Blockchain technology has the potential to make procedures more transparent and information more accessible.

Public-private keys and immutable transaction history are the two blockchain properties mainly responsible for the possibility for improved transparency. Because all transactions are signed with private keys, it is evident who made them: no one else should have access to one's private key, therefore if a transaction is signed with a key, it can be clearly connected. And, because all transactions must be signed, they can all be connected. Transparency is improved by the immutable transaction history. All transactions may be observed because the transaction history is kept. Blockchain has the potential to boost both perceived privacy protection and perceived security, as well as trust. The business layer, which sits on top of the blockchain architecture, can be used to add extra rules to the blockchain. Increased transparency is another way that blockchain may boost confidence. Firms may find this advantageous because improved trust could lead to increased revenue.

However, growing data transparency will have its own consequences: if information asymmetry is reduced, consumers may acquire control not only over their own data, but also over the value chain. Consumers can make more educated judgments when more information becomes available, allowing them to influence consumer processes. This opens the possibility of new business models. The blockchain experts' group was used in two ways: first, to come up with the criteria that were then used for use cases and expert findings; and second, to come up with the criteria that were then used for use cases and expert findings. There are two types of groups in both cases: industry experts and business specialists. The first was utilized in industry-wide studies, such as those looking at the role of trust. The latter was utilized for analysis that was specific to a corporation, such as blockchain views. The use cases were created with the help of a use case group.

The author analyzed the two use cases, case energy in the energy business and case bank in the financial services industry, using the Blockchain Use Criteria (BUC) methodology. For this scenario, two separate industries were chosen so that industry-specific variances could be detected. In both businesses, trust is extremely important. Financial services are also an intriguing industry to research because it is where the majority of the original blockchain applications were developed. The energy industry appeared to fit in nicely: it's different, yet it's also been mentioned as one of the industries that blockchain might touch first.

To sum up, the author claims that blockchain knowledge is still restricted, and that the use cases that are frequently highlighted in the debate are still at a high level. Firms aren't late to the game, but their understanding of blockchain is still limited, and the use cases that are frequently highlighted in the discussion are still at a high level.

Second, the paper presents a new perspective on business model innovation, with the goal of clarifying the idea of business model innovation and the elements that influence it. To a large extent, this study is dependable and valid. The research methodologies chosen are quite appropriate for the subject.

Because blockchain is such a new phenomenon, there is still a lot to learn about it, and doing interview research was a smart method to do so. Before deciding on research questions and techniques, specialists were consulted. This strengthened the validity of the study. Studying two case companies from different industries increases the study's external validity, and the findings can be applied at least geographically, but also to other industries.

2.22 Identification of leading blockchain startups

Blockchain firms are already forming their own ecosystems around the technology (Malin Fiedler, Philipp Sandner, 2017). They combine their own funding via initial coin offerings with the procedures and applications of other firms, such as cryptocurrency trading platforms, for example. Blockchain technology, being the first startup ecosystem to issue its own digital tokens in the form of cryptocurrencies, opens a world of new possibilities for businesses in every industry sector. In general, startups have very innovative business models and play an important role in the economy. It is critical for startups to establish a positive reputation at the outset of their operations to ensure their longevity. A framework was built and applied to an initial database of blockchain companies to determine the leading blockchain startups within the blockchain startup ecosystem.

The theoretical backdrop was first applied to the most major social media platforms for businesses, including Twitter, Facebook, and LinkedIn, and then a framework was created, which was then applied to the initial database. With almost 1,200 blockchain firms on the initial list, the blockchain startup ecosystem is well established, especially given the technology's novelty. Because venture capitalists' investments in technology are continually increasing, the ecosystem is predicted to be still developing and has not yet hit its peak.

In terms of the industries in which the startups operate, the banking and insurance sector accounts for 10 of the 15 firms. It's hardly surprise that this sector has the most startups, considering it accounts for the majority of the overall blockchain startup ecosystem. However, because the financial and insurance industry accounts for only 35.3 percent of all firms on the initial list, the two-thirds proportion of this sector among the top startups is substantially larger. In terms of startup funding, venture capitalists fund the majority of the most successful firms. Two of the firms have received investment through equity crowd funding 5, and one has received funding from a single private investor.

The majority of the leading blockchain firms are FinTech companies that operate in the financial and insurance sectors, and many of them sell cryptocurrencies. In addition to blockchain firms in the financial sector, the list of top startups also includes startups that provide information and communication services. They are, on average, younger than financial sector startups.

With Ethereum as one of the major blockchain firms and a provider of a platform as well as a programming language that allows developers to create their own blockchain apps, the foundation for many other blockchain startups that build on Ethereum has been set. So yet, no Ethereum-based firms have made the list of top startups, but this could change in the coming year as the Ethereum network grows rapidly. Daily transactions on the Ethereum network increased from 40,000 to 240,000. Many notable blockchain startups have related to Bitcoin since its inception in 2008. The startup companies' success might thus be attributed to the management's familiarity with the technology and knowledge of the benefits of blockchain-based applications.

Blockchain companies can teach mature corporations, particularly banks, which the technology is in high demand by customers as a substitute for fiat money. Some financial organizations may view blockchain technology as a disruptive innovation that will result in consumer loss. However, because the startup ecosystem is still growing and new, innovative startups are being established every day, financial institutions have time to adapt to the trend and incorporate blockchain technology. Integrating and partnering with startup technologies may also be a way for large banks and financial institutions to stay inventive and achieve the technological benefits of blockchain technology. Institutions must monitor the new market and client demand to make a judgement about whether or not to invest in blockchain technology.

The blockchain startup ecosystem is dominated by startups that tackle infrastructural problems or inefficiencies, have a strong business model, and management with experience in other high-tech enterprises or in the financial industry. Blockchain startups that solve these issues through decentralized applications gain a large market share and a good reputation on social media platforms, especially in developing countries where people seek alternatives to centralized and, in most cases, inefficient governmental and infrastructural conditions.

Aside from finance businesses, enterprise blockchain startups and startups that offer blockchain-based alternatives to centralized applications are gaining traction with customers. Their low social media score could be attributed to the fact that blockchain is still relatively obscure among the public, and individuals may not understand the technology's merits. More entrepreneurs may develop blockchain apps that aren't related to financial services because of Ethereum's evolution and its cohesive potential for new blockchain applications.

2.23 Scalable blockchain distribution network

(Uri Klarman, Soumya Basu, 2018) present bloXroute, the first Blockchain Distribution Network (BDN), which uses an effective broadcast primitive to increase a blockchain's on-chain throughput by more than three orders of magnitude without affecting the blockchain's functionality or the power balance among current system participants. Furthermore, because of the fast-underlying network, increasing performance is as simple as changing the block size and block time interval. This is accomplished using bloXroute's first-order priority of a provably neutral network design. This study proposed a protocol-agnostic networking approach to solve the blockchain scalability problem without affecting the existing blockchain paradigm or the present system design.

This study adopted a blockchain distribution network (BDN) to allow for blockchain scaling without jeopardizing the decentralization of transaction control. The main challenges were to build a BDN that could be audited by the worldwide peer network while keeping the functionality, characteristics, and power balance among present system participants. BloXroute, in essence, implements and delivers an efficient broadcast primitive to the blockchain nodes via a network of Gateways, allowing them to communicate as if they were on the same Local Area Network, even though they may be located on different sides of the globe.

BloXroute can enable blockchains to support and automate relatively routine processes with thousands of transactions per second. If a blockchain records one transaction every time a car fills up its gas tank, just supporting the United States would necessitate 400-500 transactions per second. If each vending machine enabled only four purchases per day via blockchain, the blockchain would need to be capable of 1000 transactions per second.

The purpose of the bloXroute is to let cryptocurrencies and blockchain systems scale up to thousands of on-chain transactions per second. Furthermore, it aspires to give scalability to a variety of cryptocurrencies and blockchains at the same time, by leveraging a global infrastructure to enable distributed blockchain systems in a provably neutral manner. The authors describe the system's trust model and the components that it employs to ensure scalability, eliminate discrimination, and enable new functionality for the blockchains it supports in this paper. The trust concept of bloXroute is based on two observations: Long block propagation times, for example, will make trustless P2P blockchains impossible.

Second, it was discovered that small centralized systems scale well by putting trust in a limited group of participants and giving them authority over the blockchain transactions. Such centralization undermines the one most distinguishing feature of cryptocurrencies: the spread and decentralization of transaction control.

Giving a small group of people authority over a blockchain's transactions allows those people to collude, censor, and discriminate against users, nodes, and miners. A small number of participants minimize the number of nodes a malicious actor must corrupt to gain control of the system. The bloXroute system is protocol agnostic, scaling a variety of coins and blockchains at the same time. The system interacts with both the application layer and the networking layer at the OSI transport layer (Layer 4) and offers service to whichever blockchain protocol is running at the application layer.

Finally, the research paper introduces bloXroute, the first BDN with a radically novel approach to solving the blockchain scaling problem: it introduces a global network infrastructure to boost scalability while maintaining decentralization of control over transactions in a blockchain through a neutral and auditable network design. It achieves scalability by utilizing a powerful broadcast primitive. It achieves neutrality by allowing encrypted blocks and hiding the origin of blocks through peer relaying. Finally, it achieves auditability by allowing users to explore the network actively and directly via Gateways in a methodical manner. bloXroute is protocol neutral, capable of simultaneously supporting many blockchains and completely realizing their undeniable potential. BloXroute is funded by BLXR, a token whose value is derived from 50% of all payments to bloXroute, allowing BLXRs to be exchanged for a proportional share of the BLXR-reserve, and establishing a price floor for BLXR.

2.24 Blockchain based supply chain framework for performance improvement

(Debabrata Ghosh, Albert Tan W. K, 2017) in their research, "A Framework for Implementing Blockchain to Improve Supply Chain Performance", state that Supply networks nowadays are characterized by increased competitiveness and global complexity. Supply chain managers in charge of global supply networks are always looking for ways to improve efficiency and responsiveness by collaborating and implementing new technology.

Information coordination, the impact of product and service manifestations on information complexity, the impact of customer demand manifestations on information flow, the impact of outsourcing and globalization on information flow, and new emerging threats to supply chains by affecting information vulnerability have all been studied.

Several of these issues deserve additional research and attention. As a result, in this paper, authors outlined areas where blockchain technology was most likely be used to provide supply chain solutions. The authors have developed a 3D model framework for identifying faults with current supply chain information flow, as well as designing and developing a blockchain ecosystem for supply chain management. By registering the identity and transfer of goods on the ledger as transactions, blockchain technology powered by distributed ledger helps ensure both transparency and security in supply chains. This allows any relevant information required in managing the supply chain to be recorded and shared throughout the network in a secure manner, enabling real-time supply chain collaboration. Ensure timely and reliable information sharing among supply chain partners is a crucial enabler of an effective and responsive supply chain design. For such information sharing, information technology is a vital enabler. Information management technologies, such as ERP systems, have significantly increased information sharing amongst supply chain actors over the previous several decades.

However, the utility of IT systems in terms of information sharing across supply chain partners is also decided by the information's credibility and the partners' mutual confidence. Due to confidentiality issues or a lack of coordination between supply chain entities, information sharing is difficult. Supply chain operations are likely to be the next ground where blockchain technology can be deployed in response to concerns and challenges faced by supply networks, as it has been in the financial services industry.

2.25 Blockchain based trade finance process

According to the authors, (A.V. Bogucharskov, I.E. Pokamestov, 2018), implementing numerous new ideas in trade finance can alleviate present economic difficulties because it is one of the most effective tools for sustaining the reproduction process' continuation. In many places, small and medium-sized businesses are painfully aware of the inaccessibility of trade finance for replenishing working capital. One of the reasons is a lack of trustworthy technologies that provide transparency and help to solve asymmetric information problems.

There are also other more challenges in the growth of trade finance: For starters, the volume of trade finance transactions is always changing: Interest rates, regulatory changes, and internal considerations like restricted capital and the requirement to provide depreciation all influence the system's evolution. Second, trade financing in the global supply chain is challenging to implement. Implementation necessitates significant effort from suppliers and combines the process with the finance, purchasing, and information technology divisions of businesses.

Third, bringing incentives to various participants is tough. In terms of asymmetric structures, costs, and uncertainties, suppliers, purchasers, and financiers are all independent decision-makers striving to maximize profits. Such self-serving profit maximizations frequently result in poor supply chain performance.

Improvement of software and implementation of blockchain solutions that enable companies to unite and accelerate cash flow and documentation throughout the supply chain are two of the most important factors on the path to solving these problems and the successful development of trade finance instruments. At this time, the following areas of blockchain technology application in trade financing and supply chain monitoring have been identified: Banks developing their own solutions to improve trade finance procedures, banks joining blockchain consortiums, and the establishment and development of new projects to optimize trade financing operations.

The study's methodology aims to improve the existing trade finance model based on blockchain document transactions. Authors defined strategies to improve modern financial instruments of trade finance without the restrictions of earlier models after compiling models of participant interaction in trade finance using blockchain. The two most common trade finance instruments: factoring and letter of credit (LC) are used.

The incorporation of blockchain into various trade financing instruments provides banks and their customers with a competitive advantage. At the same time, it can detect various flaws in interaction trade finance players' algorithms based solely on document exchanges. The authors made the following suggestions for a more efficient use of technology in supply chain financing: Increase the number of players, add blockchain, which allows for transactions in electronic fiat money, or a digital currency tethered to fiat money, and build arbitration on the platform itself, which allows for the resolution of major conflicts.

Finally, this research looks at the many benefits and areas of blockchain application in trade finance, as well as future possibilities for using technology in this field, such as improving cyber security, performing transactions in blockchain, and incorporating an arbitration dispute resolution mechanism within the blockchain platform. In trade finance operations, blockchain with a high level of functionality decreases document processing time, transaction costs, and promotes transparency. The question of how far the chances for using technology can be implemented remains unanswered.

The integration of blockchain technology into the banking sector is difficult. And the first constraint isn't a technological one. All financial transactions are transparent using blockchain. Not everyone is prepared to work in an environment where all participants' actions are reliably documented.

2.26 Blockchain enabled smart-contracts

Enterprises are confronted with new difficulties such as data security, stakeholder trust and transparency, decentralization of work processes, and so on. The advancement of blockchain technology and smart contracts has opened up new avenues for businesses to overcome these issues (Chibuzor Udokwu, Aleksandr Kormiltsyn, 2018). Smart contracts provided by the blockchain are computer programs that can be consistently performed by a network of mutually distrusting nodes without the need for third-party adjudication. Enterprises can collaborate and implement self-enforcing contract conditions in a blockchain network without the intervention of a third party using smart contracts.

While smart contracts offer new alternatives for businesses and various studies have been conducted on how smart contracts might be used to address a variety of difficulties confronting modern businesses, little is known about smart contract adoption in businesses. This article addresses the need by providing an overview of the smart contract-supporting commercial applications. The primary research question of this paper is how to successfully adopt smart contracts in modern enterprises?

Each participating node has a copy of the ledger, and the blockchain network is represented by nodes that are connected in peers. Virtual machines manage the nodes. The Ethereum Virtual Machine, for example, is used to power an Ethereum blockchain node (EVM). When a new block is accepted in the network, each node adds the new block to its record. Transactions are sent from the participating nodes and are time stamped. For adding new records to the ledger, all nodes in the network agree on a consensus procedure. Blocks are used to organize transactions, and once a block is approved by the network, all participating nodes add it to their copy of the ledger.

The studies are based on the time stamping virtual machine that powers the blockchain nodes, cryptography behind the digital signature, consensus method for validating transactions, and the Solidity programming language for constructing smart contracts. The authors present a list of 18 disadvantages of blockchain technology. Among the technologies affected are digital signatures (55.6 percent), consensus (50 percent), the Solidity programming language (38.9 percent), the PoW consensus mechanism (27.8 percent), and nodes (27.8 percent).

The following enterprise domains have been identified as the top application areas for smart contracts: SCM, finance, healthcare, information security, and smart city and IoT solutions. These enterprise domains are similar in that their processes typically involve the participation of multiple collaborating parties. SCM, for example, involves parties such as a supplier, buyer, transporter, and so on.

Typically, these parties do not trust one another. As a result, blockchain-enabled smart contracts become increasingly important in these domains because they provide a trustless and transparent system for storing and executing transactions (business processes). And according to findings of the study, the Ethereum blockchain is still the preferred blockchain for prototyping smart contract projects. Nonetheless, the majority of implemented projects were created for Ethereum and Hyperledger fabric blockchains.

The Hyperledger fabric is one of the blockchain tools created by the open source Hyperledger project. The Hyperledger project aims to create enterprise-wide blockchain frameworks that are compatible and interoperable. IBM is a major contributor to the Hyperledger Fabric project, and it is also a major service provider for enterprises that are implementing blockchain projects. There are issues with both public and private blockchain networks. These two networks differ in terms of who is permitted to participate in the network, which is permitted to execute the consensus protocol, and who is responsible for the shared ledger's upkeep. Because of blockchain complexity and usability issues, the use of smart contract applications in enterprises is complicated.

Blockchain networks have complexity and usability issues, particularly for first-time users, making it difficult for them to understand and use the networks. Lack of standardization of metrics and measurements for scalability, performance, and security limits the practical use of blockchains in DAOs and enterprises. Aside from a lack of standardization, there is a significant gap in practical experience with blockchain testing and usage. Furthermore, blockchain technology has architectural design flaws that make it unsuitable for enterprise processes. Consensus mechanisms in blockchain technology are hampered by a number of constraints.

To compensate miners, a transaction cost is attached to blockchain transactions, which may limit the use of smart contracts in enterprise applications. However, this does not apply to private blockchain networks because permissioned blockchains typically use voting-based consensus methods. Proof-based consensus methods reward participants with cryptocurrency in exchange for confirming transactions and adding new blocks. Cryptocurrencies are highly volatile, and enterprises cannot make long-term decisions when running enterprise applications that rely on cryptocurrencies for proof-of-concept. The other limitation of the blockchain consensus mechanism is volatility of cryptocurrencies. Long-term economic decisions are made more difficult as a result of this. Because of time scalability issues, a consensus mechanism such as Proof-of-work (PoW) may not be feasible in applications that process a significant amount of data in a short period of time. The update time increases as the number of transactions increases, and it can take several minutes to update a transaction.

Although the PoW consensus method provides security in the blockchain, it results in resource waste. Miners' required work is what secures the blockchain. Reducing the difficulty of the problem may jeopardize network security and result in attacks such as denial of service attacks.

2.27 Blockchain based information & records management system

Blockchain technology is both an underappreciated and underutilized tool within the IRM community (Rob Begley, 2017). By ensuring the key characteristics of what constitutes a record, blockchain broadly conforms to ISO15489. Although it does not verify the actual transactional record, blockchain's decentralized and immutable characteristics ensure the authenticity, reliability, and integrity of a record. Furthermore, the usability element appears to be unfriendly to users, despite the fact that it provides an additional layer of security that other technologies do not.

Blockchain relies on the internet to function, but it is just as dependable as other record-keeping systems. It authenticates transactions and records and effectively maintains their integrity. Blockchain is secure due to its immutability. Its security is enhanced by the use of a private key encryption mechanism. Blockchain, by definition, does not comply with any international standard or regulatory requirement. Blockchain comprehensively and methodically records all network transactions, regardless of format. This study addressed three hypotheses about blockchain and IRM.

The first hypothesis was that blockchain technology is both underappreciated and underutilized in the IRM community. The following key findings were determined by testing three specific areas – knowledge, use, and experience. Internet-based information sources are more popular than traditional paper-based methods. Despite this, blockchain technology has received little attention from the IRM professional community. Blockchain technology is a little-used tool because few people work with it or have used it for record-keeping.

The second hypothesis was that IRM factors have no bearing on whether or not firms embrace blockchain technology. This study focused on the organizational barriers, drivers, and attitudes toward blockchain adoption and implementation in order to determine the following key findings. Internal and external impediments noted included a lack of understanding and perceived disturbance to current processes or procedures, as well as regulatory constraints and usability.

The final hypothesis was that blockchain technology has the ability to significantly improve and enhance current IRM procedures. The fundamental characteristics of blockchain were investigated, as well as the International Standard ISO 15489-1:2016 records management. Before the opportunities that blockchain presents for IRM can be completely grasped, acted on, and integrated, it appears to me that a cultural transformation - what can be called a paradigm shift - is required.

2.28 Blockchain based retail management system

The blockchain technology itself is uncontroversial and has proven to be reliable over time, with applications in both financial and non-financial sectors (Arijit Chakrabarti, Ashesh Kumar Chaudhuri, 2017). The design of a blockchain-based system has yet to be thoroughly investigated, and little is known about the consequences of incorporating blockchain into software architecture. Bitcoin is the most well-known example of blockchain technology in use. It's also the most contentious, as it aided in the creation of a multibillion-dollar worldwide market for anonymous transactions with no official oversight.

The following are some of the advantages that blockchain technology will provide. As a result, the technology finds its use across financial and non-financial areas both:

- Compared to centralized solutions, it lowers transaction costs and enhances robustness. - Interacts with peers in a "trustless" environment.
- An immutable public ledger enables for the tracking of real-world and digital asset ownership. - Transactions serve as verifiable proof of provenance.
- Smart contracts for conditional payments and sophisticated business logic - Assets and business processes are non-reputable.
- Allows truly autonomous entities (IoT devices, distributed enterprises) to exist - Entities can define their own rules, responsibilities, and permissions

Its application in different fields, including retail, has a lot of potential. The purpose of this paper is to discuss some of the areas in the retail industry where blockchain technology can be used to benefit both customers and businesses. According to a market research analysis, the global blockchain distributed ledger market was worth $228 million in 2016 and is expected to be worth $5430 million by 2023, rising at a CAGR of 57.6% from 2017 to 2023. The key reasons propelling this market are transparency, immutability, and lower total cost of ownership. Because of the widespread usage of this distributed ledger technology across multiple applications such as smart contracts, exchanges, digital identities, payments, documents, and other related entities, the blockchain technology market is rapidly expanding.

These days, data is driving the retail industry. Retailers are attempting to focus more on personalized retailing in order to expand their consumer base and improve customer service. The blockchain technology will serve as an enabler, allowing retailers to reach their objectives more quickly. In the retail industry, blockchain has a lot of potential to help merchants improve their present business processes, which will lead to more revenue. In the supply chain, shipment tracking is crucial.

At each stage of the tracking process, blockchain can be used to store data about the shipment, such as its position, date and time, the details of the cargo handling person, the temperature, and the state of the package/product, among other things. This will allow you to see in real time if the shipment was handled correctly and arrived on schedule at any particular destination. It will also aid businesses in locating lost or damaged merchandise in shipments. Blockchain can be used to collect data on customer purchasing patterns, order placement trends, and so on. This information can be utilized to estimate demand for certain locations and propose supplies on hand to improve their just-in-time inventory system.

Because the records are immutable and a variety of analytical tools may operate on them, complex data warehousing solutions can be constructed for merchants utilizing blockchain technology. Blockchain will lower the risk of fraudulent monetary transactions on the payment front. Customers, retailers, and suppliers will be able to see the product source, if the products were created with child labor, and whether any dangerous or concealed components were present, all of which will aid merchants and customers in making purchasing decisions.

Customers can stroll through the records on the products and avoid counterfeiting by using blockchain to authenticate product authenticity, enhancing customer confidence in the product quality. By storing encrypted customer data, coupons, and discounts and making the data available to all retailers, blockchain can revolutionize the loyalty system and provide deeper insights on client records. Customers will be able to examine all of their loyalty information in one location across all shops with a loyalty warranty on blockchain.

To summarize, technology is still evolving, with a wide range of applications in various fields and businesses, and it is poised to revolutionize the world. However, it is not without its difficulties; some of them have been noted. Although blockchain is the technology that underpins Bitcoin, its applications are not restricted to the financial sector. The retail industry will begin to reap the benefits of blockchain through improved product transparency, more efficient supply chain management, and better loyalty management system, improved customer profiling, and counterfeiting prevention, among other things, resulting in increased customer satisfaction and higher profit margins for retailers. In 2016, blockchain was found to be the most disruptive technology in the retail industry, and in 2017, blockchain is progressively becoming the dominant hype term for retailing.

2.29 Blockchain in smart energy grids

The authors, (Claudia Pop, Tudor Cioara, 2018) investigate the application of decentralized blockchain technologies to provide transparent, secure, reliable, and timely energy flexibility to all parties involved in the flexibility markets, in the form of adaption of energy demand profiles of Distributed Energy Prosumers (Distribution System Operators primarily, retailers, aggregators, etc) at medium and low voltage levels, real-time control and supervision are critical for smart energy grid management and operation. Due to the increasing expansion in the deployment of Distributed Energy Prosumers (DEPs), smart grid management issues can no longer be effectively addressed with centralized ways, necessitating the development of new decentralized methodologies and architectures.

Due to a lack of grid-scale energy storage capacity, electrical energy must be used as it is generated. The development of Internet of Things (IoT) smart metering devices, combined with the prospect of renewable energy integration, has increased the level of adoption of decentralized energy networks.

The authors of this paper propose a blockchain-based paradigm for distributed control of medium/low voltage smart grids by establishing and operating a decentralized peer-to-peer energy flexibility marketplace, while the control of the energy network remains in the hands of a centralized DSO.

They have proposed a model for storing monitored energy data from IoT smart metering devices and associated energy transactions on a grid-level shared and replicated blockchain distributed ledger, as well as self-enforcing smart contracts for decentralized DR program management at the DEP level and balancing grid level energy demand with actual energy production. For DR verification and financial settlement, distributed consensus is used, allowing us to know the fraction of energy flexibility that has been enabled and transferred in near real time. At the smart grid level, a blockchain distributed ledger is built and controlled. Each DEP is equipped with IoT-based energy metering devices that record the observed data about energy output and consumption in blocks as part of the ledger. As a result, a DEP can be characterized as a peer-to-peer distributed energy network node that can keep a copy of the ledger that is automatically updated when new energy data is registered. The smart grid will be transformed into a democratic society that will no longer rely on a central authority and will be able to make any decision using smart contract rules enforced and confirmed by any grid DEP.

Furthermore, the traditional centralized management of the smart grid, which is vulnerable to single point of failure, is replaced with a decentralized approach, in which each node in the network computers and verifies statistics, transactions, control services, and payment settlements in a distributed manner.

Finally, the authors of this research developed a decentralized system for managing demand response program in Smart Grids. They combined grid features with blockchain architecture and associated smart contracts to ensure programmatic description of projected energy flexibility levels, confirmation of DR agreements, and energy demand and production balance. Using energy traces from UK building records, a prototype was built in Ethereum to validate and test the blockchain-based decentralized management. The results are encouraging; demonstrating that the grid is capable of making near-real-time adjustments to energy demand by executing predicted energy flexibility levels and confirming all DR agreements. It also paves the way for the creation of a pure peer-to-peer decentralized energy trading system without the use of an intermediary third party such as a DSO, resulting in lower energy transaction costs.

2.30 Blockchain based logistics system

Blockchain will transform business and logistics, present research on frameworks for categorizing blockchain application potentials and their ramifications is minimal (Mario Dobrovnik, David M. Herold, 2018). Academic literature in the field of transportation and logistics, in particular, has failed to distinguish between blockchain adoption (‘what to adopt') and identifying the correct business opportunity (‘where to start').

As a result, this study (1) employs Rogers' (2003) "attributes of innovation framework" to identify potential blockchain applications, and (2) presents a framework that explains four transformation phases to categorize the identified areas of application based on their effects on organizational structures and processes. This research makes two contributions: First, using an innovation framework, the authors identified potential blockchain benefits and application scenarios for and in the logistics industry, thereby providing not only a theoretical foundation for blockchain technology, but also synthesizing and highlighting real-world deployment opportunities.

Second, the report proposes a new strategy to justifying associated technological expenditures by categorizing blockchain applications based on numerous transformation phases, thereby assisting managers in determining where to begin building their organizational capabilities for blockchain now. They use Iansiti and Lakhani's approach to categorize the effects on organizations based on two dimensions: novelty and coordination effort, in order to provide an insight of which specific blockchain applications will initially gain traction.

The framework divides the two contextual aspects into quadrants, each representing a stage of technological advancement. Because of the technology's intrinsic qualities of immutability, transparency, and decentralization, blockchain applications in logistics are projected to provide a relative advantage.

For example, Kim and Laskowski and Crosby et al. emphasize the ease of access to critical data because the data is kept on several computers, resulting in a secure, duplicated, and synchronized ledger, i.e., for digital bills of lading "that cannot be secretly altered." Furthermore, under the current logistics system, the capacity to trace the origins of items or learn more about them is severely limited. The blockchain provides a safe environment for actors to share and exchange data about their goods and services.

The ability to exchange information and demonstrate to customers that their products come from safe and sustainable manufacturers could boost customer loyalty and, as a result, profits. Three blockchain-based innovations appear to offer the biggest benefits when implemented in terms of compatibility: validating items, decreasing paperwork, and end-to-end tracking.

Global supply chains transport valuable items and confirming documents such as letters of credit or bills of lading across time and place, involving several actors and thus subject to forgery, theft, and manipulation. For most logistics organizations, the best place to start is with single-use instances, which reduce risk because they can be built on existing systems and so require minimum third-party coordination. Organizations can learn the skills they need for more advanced applications by achieving proof of concept or constructing prototypes for single-use scenarios.

Another low-risk option is to use the blockchain internally as a database for apps that manage physical and digital assets, record internal transactions, and authenticate identities, where stakeholders may learn all the intricacies of blockchain technology in a controlled setting. Additional hurdles include the establishment of blockchain standards and governance frameworks in the logistics industry, as well as the cost of migrating from legacy systems to new technology settings. Due to the competitive nature of business, the logistics domain will be defined by several private blockchains rather than a single blockchain-based system.

This underlines the need for standards and mutual agreements, particularly when it comes to blockchain interoperability. Blockchain has the potential to assist validate information about a vehicle's past performance and maintenance history, not only for warranty purposes, but also for gaining traction in the truck parts supply chain. Currently, if a retailer is dealing with a foodborne disease epidemic, it can be difficult to figure out where the contaminated ingredients came from and to which locations they were delivered; as a result, tracking down the source of the contamination can take weeks.

To summarize, the goal of this research was to uncover potential blockchain applications in logistics, as well as to show and discuss real-world instances. This evaluation was carried out using a framework to determine the impact of their implementation on organizational structures and processes.

In order to define suitable applications, the attributes of innovation framework was utilized in the first step to discover probable use cases based on five innovation characteristics: relative advantage, compatibility, complexity, trialability, and observability. The second step introduced a new paradigm that identified four distinct transformation phases and explored real-world blockchain applications and their effects on logistics structures and operations. The framework will aid logistics managers in better comprehending the various aspects of blockchain difficulties, such as desirable or even required degrees of collaboration and consensus, as well as legislative and regulatory barriers. Finally, the combined usage of the applied frameworks provides as guidance for academics undertaking research in the disciplines of innovation adoption and decision-making.

2.31 Blockchain for the internet of things

In the Internet of Things (IoT) situation, the blockchain and, as a rule, Peer-to-Peer approaches could assume a significant part in the improvement of decentralized and information serious applications running on billion of gadgets, saving the security of the clients **(**Marco Conoscenti, Antonio Vetr`, Juan Carlos De Martin, 2016). The exploration destinations were to comprehend whether the blockchain and Peer-to-Peer approaches can be utilized to cultivate a decentralized and private-by-plan IoT. As characterized by ITU, the Internet of Things (IoT) alludes to the organization of various actual items (20 billion by 2020, as indicated by Gartner which are given Internet association.

Such gadgets obtain data about the general climate, and they speak with one another and with programming frameworks through the Internet. As an outcome of such rich cooperation, they likewise produce a lot of information, thus usable to empower subordinate administrations. Regardless of the advantages given by these administrations, basic security issues may emerge. That is on the grounds that the associated gadgets (the things) spread delicate individual information and uncover practices and inclinations of their proprietors. Individuals' protection is especially in danger when such delicate information are overseen by concentrated organizations, which can utilize them: indeed, Edward Snowden's disclosures showed that individuals' information put away by internet and media transmission organizations have been misused inside a mass observation program, i.e, the PRISM program. A private-by-plan IoT could be encouraged by the blend of the blockchain and a P2P stockpiling framework.

Touchy information delivered and traded among IoT gadgets are put away in such capacity framework, whose P2P nature could guarantee security, power and nonattendance of weak links. Joined with this stockpiling framework, the blockchain has the central part to enroll and confirm all tasks performed on IoT gadgets information. Every procedure on information (creation, adjustment, cancellation) is enlisted in the blockchain: this could guarantee that any maltreatment on information can be distinguished.

According to results, it is shown that the greater part of the friends known by a companion of the Bitcoin network dwell in its equivalent self-governing framework. This implies that the P2P network isn't all around associated and there could be challenges in the hand-off of new squares added to the blockchain. This makes the accomplishment of circulated agreement hard. The creators shows that an aggressor which controls an enormous number of hubs, regardless of whether with not high computational capacities, could accomplish a high part of the absolute computational force in little blockchain frameworks where there are not many diggers. This could undermine the honesty of the framework, in light of the fact that the aggressor would have the option to cause deliberate forks.

Another attack, called history-update assault, is brought up in. The creators express that, for the situation an assailant possesses a computational force different of the computational force of fair hubs (e.g., multiple times higher), it can deliver a part of the blockchain which could surpass the current one as far as trouble of the PoW, thus could be acknowledged by different excavators, hence changing the historical backdrop of the blockchain. In, the creators show that an assailant could postpone conveyance of squares or exchanges to different hubs in the Bitcoin P2P organization. This could bring to: more benefits in self centered mining, if the aggressor can try not to convey of squares from genuine excavators to a segment of the organization; forswearing of administration, on the grounds that, if the assailant controls a few hubs, it can forestall scattering of data. Four classes of de-anonymization methods: different sources of info, change address, relationship with IP and use of concentrated administrations are recognized.

At the point when a client gives an exchange with different addresses as sources of info, she uncovers to claim that load of addresses. In frameworks like Bitcoin, in certain exchanges clients send coins to a specific location that has a place with them, called change address. It has been archived that the blockchain can be utilized for distinguishing maltreatments on information and characterizing access strategies, without the need of entrusting individuals' information to brought together organizations.

The versatility issue of the blockchain is accounted for. As a matter of fact, there are two principle versatility issues. The first is that, when the quantity of exchanges develops, the blockchain expansions in size, and it gets costly to store it, particularly for IoT gadgets with restricted assets. This issue can be tended to by the layered engineering portrayed additionally for the trustworthiness. In this engineering, where the blockchain is isolated from the application layer, IoT gadgets with restricted assets store just the segment of the blockchain they need for their own exchanges (the purported slender customers effectively present likewise in Bitcoin). The subsequent issue is the low throughput of exchanges - a commonplace issue of the Bitcoin blockchain, which we didn't discover in the papers, however is to a great extent examined inside the Bitcoin people group. The low throughput is because of the trouble of the PoW and to the most extreme size of a square, which is set to 1 MB. This issue addresses a tradeoff among adaptability and security. Truth is told, with respect to the PoW, if its trouble is diminished, the throughput will be higher, and yet it will be simpler for an assailant to cause forks in the blockchain. With respect to hinder size, if its greatest is expanded, the throughput will increment as well, however it will be harder to approve exchanges: this suggests that solitary few hubs will actually want to do it, thus the force of Bitcoin will be gathered in couple of hands. Once more, an answer could be a layered design, where not all tasks performed at the application layer require an exchange in the basic blockchain. Notwithstanding, this may not be sufficient for the IoT, where the blockchain should uphold billion of gadgets. Definitively, regarding the trustworthiness and the flexibility, it is tracked down that huge blockchain frameworks like Bitcoin are the most secure, and yet Bitcoin adaptability issues make it minimal appropriate for the IoT.

2.32 Blockchain in electronic medical record system

Patient's clinical record is significant data for the cycle of clinical therapy of patients including an individual information, individual clinical profile, hypersensitivities, and so forth (Lakkana Wanitcharakkhakul, Siriluck Rotchanakitumnuai, 2017). A few clinics embrace data correspondence and innovation to oversee patient clinical records - purported electronic medical record system. The patient information can be connected inside the clinics. The current electronic clinical record framework isn't powerful, as medical clinics have utilized various projects. The electronic clinical record frameworks in clinics are private and created to use inside the association as it were. A few medical clinics have fostered their own framework, while some have bought prepared to-utilize application programming. It can't be associated with different medical clinics.

These days, there are numerous advances accessible that assistance in recording wellbeing data for wellbeing analysis and treatment (Peterson et al., 2016). Nonetheless, organizations are ordinarily reluctant to share data in view of protection concerns and fears that the transmission of data may cause information spill. Despite the fact that a few advancements can tackle these issues, it's anything but worth the venture. It is important to have normal comprehension of the design of the information for dividing data between organizations. These issues are as yet significant impediments. Blockchain is one of the mainstream advances in numerous spaces since it is secure and has movable stockpiling to manage protection concerns, and offer data.

With the progression of blockchain innovation, it can possibly oblige a trade of existing information securely. The activity of blockchain contains data classified, precision and prepared to-utilize data. Blockchain has a component to access into the framework and data with a code for the security of the information. On the off chance that there are any progressions to the data, all individuals from the organization can confirm the precision of the data. For medical care, blockchain innovation will help in cost saving and expanding usefulness essentially, which are what the business needs to make new qualities, improve encounters in medical services and fabricate patient-focused wellbeing frameworks working with synergistic execution simpler, more secure and more successful.

The consortium blockchain type was utilized as an example plan of action of electronic clinical record blockchain which can produce pay by offering token to patients. Patients who join the electronic clinical record blockchain can permit the individuals in the blockchain organization to get to their clinical records.

Various relapses were utilized to examine the relationship of the blockchain innovation acknowledgment model. The outcomes showed that apparent handiness and relative benefit significantly affect execution anticipation. The outcomes showed that the capacity, security and protection and hazard factors significantly affect trust in blockchain innovation framework. Trustworthiness has no effect. Security and protection factor showed the most elevated effect on building trust in blockchain innovation. At long last, execution hopes highest affects expectation to receive the blockchain innovation for the electronic clinical record framework. Seen generally safe and confidence in the blockchain innovation framework likewise affect acknowledgment.

The research result showed that the most compelling component influencing to acknowledge the blockchain innovation for the electronic clinical record framework is execution anticipation which incorporates the acknowledgment of mechanical advantages and relative benefit. Seen generally safe of the blockchain framework affects appropriation. The trust factor affects electronic clinical record blockchain reception.

The consequences of this examination has helped medical care associations, both private and public clinics and the Ministry of Public Health, in considering and intending to apply blockchain innovation to the emergency clinic's electronic clinical record framework. The outcomes have additionally leaded to additional advancement of the working framework and other applicable regions to react to the necessities of the clients.

2.33 Blockchain technology relationship with supply chain management

Globalization of supply chains makes their administration and control more troublesome. Blockchain innovation, as a dispersed advanced record innovation which guarantees straightforwardness, recognizability, and security, is showing guarantee for facilitating some worldwide production network the executives' issues (Sara Saberi, Mahtab Kouhizadeh, Joseph Sarkis & Lejia Shen, 2019). Blockchain innovation and savvy contracts are fundamentally inspected with likely application to store network the executives. Neighborhood and worldwide government, local area, and buyer pressing factors to meet supportability objectives brief us to additionally examine how blockchain can address and help production network maintainability. A piece of this basic assessment is the manner by which blockchains, a conceivably problematic innovation that is from the get-go in its development, can beat numerous possible boundaries. Four blockchain innovation reception boundaries classes are presented; between hierarchical, intra-organizational, specialized, and outside obstructions. Genuine blockchain-drove change of business and production network is as yet in progress and in its beginning phases; we propose future examination recommendations and headings that can give experiences into beating boundaries and reception of blockchain innovation for production network the board.

Current stock chains are intrinsically unpredictable including multi-echelon, geologically disconnected elements contending to serve customers. Globalization, different administrative approaches, and changed social and human conduct in production network networks make it practically difficult to assess data and oversee hazard in this mind boggling network. Wasteful exchanges, extortion, pilferage, and ineffectively performing supply chains, lead to more noteworthy trust deficiency, and in this manner, a requirement for better data sharing, and certainty. Discernibility is turning into an inexorably dire prerequisite and a basic differentiator in many inventory network enterprises including the agri-food area, drug and clinical items and high worth merchandise. Extravagance and high worth things whose provenance may somehow or another be dependent on paper endorsements and receipts can be lost or changed. Truth be told, absence of straightforwardness in the stockpile worth of anything forestalls production network elements and clients from checking and approving the genuine worth of that thing. The expense engaged with taking care of go-betweens, their unwavering quality, and straightforwardness further confounds dealing with this recognizability in the inventory network. Vital and reputational serious issues emerge from these dangers and absence of straightforwardness. Current inventory chains depend vigorously on brought together, now and then divergent and independent data the board frameworks, which are inside associations; for instance, undertaking assets arranging frameworks, which has its own traps. Inventory network substances require critical trust for depending on one single association or dealer for putting away their touchy and important data.

Inventory network practice and methodology is likewise confronting developing pressing factors to consider and confirm store network manageability. Manageability has been characterized by the triple-main concern idea that incorporates equilibrium of natural, social, and business measurements while dealing with the inventory network.

Four major entities play roles in blockchain-based supply chains: Registrars, who provide unique identities to actors in the network, Standards organizations, who define standards schemes, such as Fairtrade for sustainable supply chains or blockchain policies and technological requirements. Certifiers, who provide certifications to actors for supply chain network participation. Actors, including manufacturers, retailers, and customers, that must be certified by a registered auditor or certifier to maintain the system trust. Influences on the supply chain product and material flows also exist. Every product may have a digital blockchain presence so that all relevant actors can have direct product profile access.

Safety efforts might be drawn set up to line access, where just the gatherings with the right advanced keys approach an item. There is a scope of information that can be gathered, including the situation with the item, the kind of item, and the guidelines that are to be executed for an item. The blockchain innovation can feature and detail no less than five key item measurements: the nature (what it is), the quality (how it is), the amount (the amount of it there is), the area (where it is) and the possession (who claims it at any second). Along these lines, the blockchain eliminates the requirement for a confided in focal association that works and keeps up with this framework and permits clients to examine the continuous chain of authority and exchanges from the crude materials to the end deal. This data is recorded in records as exchanges happen on these numerous blockchain data measurements; with undeniable updates.

Blockchain impacts both production network cycle and item the board, and monetary exchanges between various organization parties. A key potential blockchain production network advantage is the disintermediation of monetary go-betweens, including installment organizations, stock trades, and cash move administrations. This will make exchanging measures among accomplices more productive. Shortcomings in store network monetary streams can be decreased through store network finance instruments and strategies, for example, invert calculating and dynamic limiting saving organizations a huge number of dollars. Shrewd agreements are equipped for getting sorted out monetary game plans and would guarantee that adequate assets are accessible to the undertakings and that everybody is paid in a convenient way.

Albeit an expansive assortment of blockchain innovation applications in the inventory network can exist, they are industry, item or administration, or administration centered. To represent a useful blockchain production network application we turn our conversation to supportable stock chains. Energy is working towards manageability arrangements. Administrative, customer and local area tension on organizations and their inventory chains to work on the supportability of their stock chains and their items. Blockchain innovation can uphold information assortment, stockpiling, and the board, supporting huge item and production network data. Receptiveness, straightforwardness, nonpartisanship, dependability, and security for all production network specialists and partners can exist in this innovative setting. Monetarily, embracing blockchain innovation can profit a firm and its production network from various business measurements influencing their financial exhibition. We give a few models, out of numerous for making the financial business case for blockchain innovation in the store network. Blockchains can bring about store network disintermediation where fewer levels bring about exchange expenses and time decrease, lessening business squander in the production network.

Blockchain innovation can possibly add to social production network maintainability. Making data steady and unchanging is one method of building production network social supportability. Given that data can't be altered without assent by approved entertainers, blockchains can forestall degenerate people, governments or associations from holding onto resources of individuals unreasonably. Likewise, blockchain innovation can obstruct loathsome specialists and consider the degenerate responsible for both social and individual wrongdoings. Blockchain innovation additionally helps in natural store network supportability. It can do as such according to various point of view applications. In the first place, following inadequate items precisely and recognizing further exchanges of the items can help lessen the improve and review, which helps decline asset utilization and diminishing ozone harming substance discharges.

Indisputably, the hindrances of blockchain appropriation in inventory network are inspected as multi-layered issues which influence the connection between store network accomplices as well as accomplices' workers and their partners. Also, the innovative obstructions relating to blockchain reception are incorporated and many originate from blockchain innovation youthfulness. Framework related issues of blockchain innovation, which can restrict its appropriation, require more clarity of mind in future examination and viable specialized answers for address the versatility issues should be more considered. More exact examination is needed to investigate the meaning of the different obstructions and distinguish the causal connections among them. More extensive utilization of blockchain innovation for business purposes has effectively begun and upheld by some driving organizations, like IBM, Boeing, Microsoft, and SAP.

2.34 Blockchain technology in e-health

(Juergen Seitz, Nilmini Wickramasinghe, 2017) in their research stated that, generally, medical services has been a loafer with regards to receiving propels in innovation; be that as it may, this delay has all the earmarks of being diminishing all the more as of late and we are seeing the embracement of blockchain innovation in medical care. Instances of blockchain innovation in e-wellbeing are to date centered generally around electronic wellbeing records. The interaction of electronic remedies and prescription administration has not at this point been thought of. This cycle offers an assortment of chances for automatization and digitalization. Further, there is a huge potential for cost reserve funds not just for insurance agencies.

The idea driving Bitcoin is presumably these days the most developed blockchain application and the most examined idea of blockchain innovation in scholarly world. In any case, there are more thoughts and ideas in different regions and in different businesses. There are additionally ideas created in the space of e-wellbeing. Frequently it appears to be that there is just a thought. There are additionally ideas created in the space of e-wellbeing. Frequently it appears to be that there is just a thought. The most complex methodology is by all accounts MedRec model for electronic wellbeing records and clinical examination information. Electronic wellbeing records (EHR) are a touchy region. Despite the fact that, there exist HIPAA Privacy Rules and EU General Data Protection Regulation a many individuals don't confide in EHR frameworks, particularly in Germany. Consequently, the thought is in the first place an application where a ton of organized information is naturally prepared by a few vested parties: the cycle of electronic solution.

A significant number of the dangers and concerns related with EHR the executives can be alleviated with blockchain. A blockchain is a dispersed information base framework that monitors records. As records are added to the blockchain they are requested in blocks and each square contains timestamp connections to the connected squares. Blockchain records are secure and effectively evident. As occasions or exchanges that are caught as records happen, decentralized check of their credibility is done by greater part agreement in networks. Blockchain can fill in as "an open, appropriated record that can record exchanges between two gatherings productively and in an unquestionable and lasting manner.

The actual record can likewise be customized to trigger exchanges consequently. Numerous nations have considered electronic remedies as a vital part of their e-wellbeing arrangement. During the time spent electronic solution blockchain innovation permits to plan drug the board as a shrewd agreement. A clinical specialist doesn't just recommend prescription he/she can likewise control and in some sense direct the drug cycle distantly. A prescription gadget as a wise Internet of Things gadget can either remind the patient to take medication to impede gluts and additionally to answer to the specialist patient's conduct. Shrewd agreements additionally permit dealing with routinely conveyance, yet additionally interference of allotment if the patient or the insurance agency doesn't pay. Likewise the entire clearing interaction can be automatized.

However long the patient can take medication actually without anyone else or herself blockchain innovation and shrewd agreements cannot just help the medicine interaction, it can likewise automatize and assist with controlling the cycle. For medium weighty illnesses this likewise implies less nursing staff particularly as long as patients can live for their own at home. Indisputably, the goal of this paper was to prefer blockchain innovation as appropriate for aiding electronic remedies to address current concerns and difficulties.

2.35 Blockchain-Empowered D2D network

According to the authors, (Zhen Hong *, Zehua Wang, Wei Cai and Victor C. M. Leung, 2017) with the growing need for local services, device-to-device (D2D) communication is becoming an increasingly significant technology in future networks. In the D2D network, for example, resource sharing provides ubiquitous availability, flexibility, low latency, and low cost. These traits, on the other hand, provide obstacles when it comes to developing a good resource sharing system in a D2D network. User mobility is one of the most important considerations when building a cooperative D2D computational resource sharing system, as reciprocal communication may not be available on a consistent basis due to user movement. A prior project showed and proved how connectivity may be implemented into cooperative task scheduling among D2D network users to reduce average job execution time.

There are questions regarding whether, despite its effectiveness, this form of job scheduling technique is fair to all users. In other words, it can be unjust for users who donate a large amount of computational resources but receive less in return when they are in need. The authors presented a new blockchain-based credit system that can be included into the connectivity-aware job scheduling scheme to ensure fairness among D2D network users. The way people perform computer activities for everyday applications like stock trading, gaming, and so on is changing because to advances in computing technology. The use of traditional desktop computers for big computational tasks has grown to include other computing methods such as cloud computing.

Most gaming computational chores are performed in the cloud through cloud gaming services such as PlayStation Now and GameFly, which eliminates the need for gamers to upgrade their computing gear on a regular basis. By transferring most computational chores to the cloud, stock market investors can now manipulate stock trading on their mobile devices. Mobile data and computational traffic can be given to consumers via various channels to reduce the pressure on wireless cellular networks and the cloud (e.g.,WiFi, D2D communications).

Offloading of mobile data and computation is referred to as mobile data and computation offloading. However, because the number of open-accessible WiFi access points is limited, as is the availability of economical cloud computing services, mobile data traffic cannot always be offloaded to WiFi networks. In D2D networks, mobile traffic and computational activities can work together to fully leverage the benefits of data and computation offloading. Mobile devices in close proximity can be connected in a D2D way via WiFi Direct, Bluetooth, and other methods to share data and tasks. D2D data and computation offloading is the term for this.

The proposed system has two primary components: cooperative work scheduling to improve user effectiveness (e.g., average job execution time) and a blockchain-based credit system to offer fairness and incentives. Traditional credit systems, such as centralized banking and membership services, are losing customer confidence because users are not actually in charge of their accounts, as evidenced by the recent spike in interest in decentralized blockchain technology. The central power has the ability to change user credit or produce credit out of thin air, potentially resulting in user losses.

A number of things can influence the performance of our cooperative network with the credit system in a D2D network. The following are the elements:

- Effect of initial credit: The initial credit provided to each user is varied to see how system will be affected.
- Effect of mean maximum wait time: The mean maximum wait time during the random generation is varied to see how the performance is affected.
- Effect of mean task size: The mean task size of each requester in a task period during the random generation is varied to see how the performance is affected
- Effect of time elapsed: The simulation on multiple task periods is run and observed how system performance changes over time.

A cooperative computational task can be run in a virtual machine and then moved throughout the D2D network to multiple devices. Although virtualization adds overhead in terms of performance and management, the flexibility it provides in terms of network resource management makes it very tempting. The ability to relocate virtual machines to a different physical host while keeping applications running adds to the appeal of computational resource virtualization and sharing in the D2D network.

The system faced few challenges also which are: a) Efficiency: In the system, users are encouraged not only to compete for block rewards, but also to help their friends, increasing the efficiency of idle computational resources. b) Privacy: Because the blockchain is a public record, any node in the network may observe all transactions, transacting parties' privacy concerns persist. c) Interference in the D2D network: Due to the short duration of D2D communications and coordination from the super node, we down played the effect of mutual interference in the D2D network in this study.

Finally, the authors create a blockchain-enabled credit system on top of the D2D network's connectivity-aware computational resource sharing mechanism. If their balance is insufficient, selfish users who only wish to get support from peers but not contribute will not be awarded any helper assistance based on the blockchain-based credit system. Our method significantly reduces average task execution time for requesters in the D2D network, according to simulation results based on a realistically analyzed mobility model.

The system can maintain a low level of selfishness by sacrificing a small portion of average task execution time.

2.36 A Technology Acceptance Model (TAM) Analysis

The technology acceptance model (TAM) is a useful analytical tool for researching the social mechanics of technology adoption, and it has gotten a lot of attention in the literature **(**Daniel Folkinshteyn & Mark Lennon, 2018). Despite the fact that empirical support for the model varies depending on the situation, it remains a popular and effective conceptual framework for analyzing factors that influence technology adoption or rejection by important constituencies. Bitcoin is a distributed digital currency whose disruptive and disintermediating character has spurred the explosive growth of the financial technology industry in recent years. The blockchain, Bitcoin's distributed, verifiable, and immutable public transaction log, promises quick, low-cost peer-to-peer financial transactions as well as enormous efficiencies in the transfer of other assets via overlay networks.

The authors use the TAM framework to study features of the technological adoption process in the case of Bitcoin as a currency and the blockchain as a financial technology, based on an exhaustive survey of the available academic and practitioner literature on both TAM and Bitcoin. The authors offer findings from both the developer and end-user perspectives in order to highlight parallels and contrasts in how different stakeholders accept this new technology.

The technology acceptance model (TAM) is a theory of information systems that models the decision-making process by which users decide whether or not to adopt and deploy new technology. The theory is a development of the theory of reasoned action, which aims to explain consumer behavior. The adoption of a particular technology is dependent on two primary considerations: perceived ease of use and perceived utility by the target user, according to TAM's tenets.

Perceived ease of use (PEU): Davis (1989) defines perceived ease of use (hereinafter PEU) as “the degree to which a person believes that utilizing the system would be painless.” The importance of PEU, according to Davis, is backed by Bandura's (1982) research on the notion of self-efficacy, which is described as "judgments of how well one can execute courses of action to deal with potential problems."

Perceived usefulness (PU): Davis (1989) defines perceived usefulness (hereinafter PU) as "the degree to which a person believes that employing a particular technology will increase her/his job performance." TAM has been especially useful in assessing various implementations of web-based technologies, given its predecessors in consumer behavior theory with the introduction of the World Wide Web. TAM has been applied to eLearning and education by a variety of scholars, with several publications investigating student and faculty adoption of web-based learning technology.

There are two primary components of the Bitcoin system that require their own discussion. One is, of course, Bitcoin, which can be used to make financial transactions across the street or throughout the world with equal ease. The blockchain, a distributed log of transactions that is Bitcoin's key invention, is the other underlying architecture that allows for decentralized consensus and time stamping.

The blockchain not only supports the operation of Bitcoin as a currency, which can be successfully employed as a remittance system (Folkinshteyn, Lennon, & Reilly, 2015a), but it also enables a slew of other possible uses that necessitate reliable, high-integrity, auditable recordkeeping. While bitcoins are required to make transactions on the blockchain, the benefits of blockchain technology can be leveraged to improve the efficiency of other transactions by creating an agreed-upon layer where specific fractions of bitcoins are designated to represent other assets—such as shares of stock or real estate titles.

Because bitcoins have the attributes of a digital version of physical cash—once spent/lost/stolen, they are not recoverable—computer system security is more important with Bitcoin than with almost any other sort of application. As a result, for a firm that handles a large volume of bitcoins, both its own and that of its customers, security is critical. For most other e-commerce applications, a security breach in a business system can result in a slew of negative consequences that can be costly, but not to the level that a breach of a system that houses bitcoin keys would result in an immediate and complete loss of funds.

With its decentralized, proven consensus mechanism, the blockchain has been offered as a useful solution to a variety of problems other than money. Due to its distributed structure, the blockchain enables for broadly usable high-fidelity record keeping that is easily auditable and very robust. In a variety of applications, this has the potential to reduce the cost of recordkeeping. The blockchain is also a relatively adaptable and extensible media. By including a cryptographic digest of your document, concept, or other data in a bitcoin transaction, you can provide irrefutable proof of the material's existence at the time it was added to the blockchain.

To summarize, blockchain technology applications outside of the financial sector are still in the early phases of development, but they have attracted substantial interest from a number of big financial institutions and show great potential due to its strong and verifiable recordkeeping capability. While these applications avoid the technological and regulatory risks connected with Bitcoin's monetary features, there are still a number of application-specific concerns to consider. Bitcoin and blockchain technology in general are useful complements to traditional financial and record-keeping technologies, but they are not perfect substitutes for all applications. The TAM is a useful foundation for further research into this rapidly changing financial technology.

2.37 Credit evaluation system based on blockchain

(Dianhui Mao, Fan Wang *, Zhihao Hao and Haisheng Li, 2018), in their research, stated that, farmers, production factories, distributors, merchants, and consumers are all part of the food supply chain, which is a complicated system involving many "stakeholders." One of the key elements that lead to food fraud is "information asymmetry" between stakeholders. According to certain recent studies, implementing blockchain could assure food safety. They do, however, prefer to focus on food traceability rather than food monitoring. This research proposes a blockchain-based credit evaluation system to improve the efficiency of food supply chain supervision and management. The technology uses smart contracts on the blockchain to collect credit evaluation text from traders. The collected text is then directly evaluated by a deep learning network known as Long Short Term Memory (LSTM). Finally, the credit performance of traders is utilized as a benchmark for regulators' oversight and management. Traders can be held accountable for their activities during the transaction and credit evaluation process by using blockchain. Regulators will be able to collect more reliable, authentic, and sufficient data on traders. Experiments reveal that using LSTM instead of classic machine learning algorithms like Support Vector Machine (SVM) and Navie Bayes (NB) to assess credit evaluation text yields better results. The system has a user-friendly UI for consumers' convenience.

This study uses blockchain technology to develop a credit rating system to improve the monitoring and management of traders in the food supply chain. Smart contracts, which are written in "chaincode," provide the entire flow of processing logic for the system. The solution uses hyperledger blockchain to address the issues of different authentications and permissions required for different roles in the food supply chain (traders and regulators). It also ensures that traders (or evaluators) can be held accountable for the credit evaluation procedure while maintaining their anonymity.

The merge system is in charge of fusing blockchain technology with the LSTM deep learning model. It uses a trained LSTM model to analyze and process the credit evaluation text about traders directly. When compared to traditional methods, the blockchain-based approach has numerous advantages. The features of distribution, detrusting, security, transparency, and traceability, for example, have been applied in food chain and food traceability studies.

Currently, major electronic trading platforms such as "taobao.com" and "eachnet.com" have credit evaluation systems in place to assist authorities in determining traders' reliability. Customers' assessments on this e-trading platform can be divided into two categories: "praise" and "poor review," each corresponding to an integral evaluation. They directly add or deduct the original credit scores using the accumulated credit rating methodology. The credit evaluation system that combines hyperledger blockchain and LSTM is made up of two distinct modules:

Collect transaction and credit evaluation information: This module is primarily intended for trading roles. Traders can use smart contracts, which are written in "chaincode," to perform transactions through the application's interface. When a deal is concluded, smart contracts allow traders to subjectively evaluate their trading partner. During this process, the information of transaction and credit evaluation about the traders is all collected into the ledger.

Implement the process of credit evaluation for regulation: Smart contracts on the blockchain provide regulators immediate access to the ledgers, allowing them to search and acquire information from traders. The module will use the trained LSTM model to analyze and interpret the sentiment of the acquired text when regulators obtain credit information text about traders.

Finally, the system uses LSTM to provide a credit evaluation result ("positive" or "negative"), which is then fed back to regulators. These details, such as credit evaluation outcomes during the evaluation process, are all recorded in the ledger.

Credit assessment-classification tests with binary-class LSTMs are conducted in the study, and the model categorizes each given credit evaluation result into the levels "positive" and "negative." The credit evaluation of "praise" and "poor review" is represented by "positive" and "negative" accordingly. Depending on the credit evaluation result, the regulatory agency in the food supply chain can verify and take appropriate measures in a timely manner.

Finally, this study presents a credit evaluation system based on blockchain technology and demonstrates that the suggested method is beneficial in the field of food safety. The blockchain maintains the integrity of transaction and credit information for dealers in the food supply chain. Because traders are held accountable for their activities when trading on the blockchain, it resolves the dilemma of "asymmetric information" amongst "many stakeholders." The system also collects and analyses credit evaluations of traders in the food supply chain using blockchain technology and the deep learning network LSTM.

By creating and reporting back the credit evaluation result to regulators, it improves the effectiveness of supervision and management. The experimental results suggest that using the LSTM model, the credit evaluation system based on blockchain is possible and effective on the Chinese text dataset concerning reviews.

It is necessary to investigate a strategy for more precise and effective multiple classifications of multi-class emotion-tags. The quantity of reviews in the text dataset in

Chinese is insufficient from a dataset perspective, limiting the representation of models to precisely analyze the sentiment of credit evaluation. Blockchain still has a number of significant flaws. For example, each node on the blockchain network must record the entire blockchain's history, causing the blockchain's expanding size to become a significant source of concern.

2.38 Blockchain for research

Blockchain, according to (Dr. Joris Van Rossum, 2018), could revolutionize the function of publishers in the future, and it could play a significant role in research beyond scholarly communication. It is also examined, how blockchain can impact scholarly communication in a variety of ways, including transparency, trust, reproducibility, and credit

The study demonstrates how blockchain technology has the potential to address some of the most pressing concerns in scholarly communication today, such as costs, openness, and universal access to scientific knowledge. Permissionless vs. permissioned blockchains, as well as public vs. private blockchains, are affected by two separate criteria. The ability to use a blockchain is determined by whether it is public or private; private blockchains limit access to the chain to specific parties. Any node on a permissionless blockchain can do anything, including adding blocks to the chain. Certain nodes in permissioned blockchains are given permission to do specified functions. The use of blockchain technology for managing a variety of digital assets, such as educational and medical data, is being investigated, and it will have an impact on businesses such as publishing, retail and manufacturing, healthcare, and government.

The current state of the blockchain is compared to the early days of the internet because of its potential impact on various industries and sectors. Research necessitates the use of communication. Research relies on the successful interchange of ideas, hypotheses, data, and outcomes as a truly collaborative enterprise. This interchange must transcend geographical and temporal boundaries, allowing scholars to engage with peers from around the world and build on the work of predecessors. There is widespread agreement that this communication poses major obstacles in its current form. Scholarly communication is thought to be hampered by legacy workflows, obsolete publication paradigms, and commercial motivations that are diametrically opposed to scientific goals. Fundamental issues with the peer review process, which is at the heart of scholarly communication, have received a lot of attention in recent years. The perceived issues are numerous. Reviewers are undervalued and underappreciated, with their labor going unappreciated for the most part. As the number of articles submitted to journals rises, so does the need for more reviewers, making it increasingly difficult to locate qualified reviewers.

Although research is basically a non-commercial activity, the industry of scholarly communication, which is dominated by a few huge publishing behemoths, is one of the most lucrative in the world. This has a number of consequences. Commercial publishers' high subscription rates put a strain on library budgets, implying that not all content is made available to scientists at universities. This has contributed to the popularity of Sci-Hub, a website that offers over 62 million papers and articles for direct download, often infringing on publishers' copyright.

Similarly, peer-to-peer paper exchanges are done through the social network Research Gate, bypassing publishers. Open access, a paradigm in which payment is shifted from the reader or library to the author, providing universal access to the article, was created in part as a reaction to the challenges connected with the subscription model.

Many projects have sprung up in response to the challenges of scholarly communication in an attempt to make science more open, transparent, rigorous, and effective. Over the previous few decades, we've seen a slew of initiatives from a wide range of stakeholders, including funders, universities, publishers, researchers, and entrepreneurs. Alternative criteria were created, and cross-industry groups and discussion forums were formed with the goal of providing long-term changes in academic communications. However, despite its well-known difficulties, intellectual communication has remained remarkably unaltered across decades, if not centuries.

Researchers would work in a different way if they used a blockchain for study. Academics currently use a variety of - and largely unrelated - systems in their research workflow. Spreadsheets or lab software, for example, are used to record the findings of an experiment. An article is created utilizing a local writing application or a cloud-based collaborative writing tool once the results have been gathered. After that, the manuscript is submitted to a publisher using a submission mechanism. The manuscript is converted to PDF and HTML and hosted on a publisher site, where it may be downloaded after it has been reviewed and accepted.

Librarians frequently assist access to this publisher platform. Citations are gathered in citation databases, which are provided by libraries or through publicly available databases. This approach would be extremely different in a 'blockchained' science. Blockchain creates a shared infrastructure where all transactions are saved and stored, allowing for decentralized, self-regulating data. In essence, scientific knowledge is a big, dynamic body of information and data that is collectively created, edited, used, and shared, which is ideal for blockchain technology. The blockchain offers a number of advantages, one of which is that it makes the platform decentralized, meaning that there is no single owner and everyone has access to the same data.

Finally, the launch of a cryptocurrency might be accompanied by the development of a science blockchain, which would add an economic layer to the blockchain. This 'bitcoin for science' might be used to provide micropayments to publishers for information consumption, as well as a monetary reward system for researchers. The successful implementation of a blockchain for research will be contingent on collaboration among all stakeholders, including funders, governments, institutions, publishers, and researchers themselves.

2.39 Blockchain applications in fundamental analysis for investment management

Numerous local and international surveys have determined that individual investor involvement in the stock market is dwindling, with no signs of change in sight (Audrey Lim Li Chin, Wong Wai Wai, 2018). As of January 2018, retail participation was 14.6 percent. Aside from that, Bursa Malaysia's vitality is lagging behind those of its Asian peers, such as Hong Kong and Singapore (Bursa Malaysia, 2015).

Market transparency is one of the factors that influence market liquidity. Market liquidity improves as a result of increased market openness. Market players benefit from accurate, relevant, and timely trustworthy data on market conditions since it reduces uncertainty and, as a result, irrational risk-taking involvement in the market, which contributes to a market crash.

The main goal of this research was to show how this new blockchain technology, specifically its super efficiency in asset transfers, data correctness, irreversible transactions, and transparency in fundamental analysis, may dramatically increase investor trust. Fundamental analysis is essentially used to make long-term projections of future values based on past data and a collection of other elements that may influence demand and supply.

The following propositions were proven after a conceptual framework was developed:

Proposition 1: Fundamental analysis benefits from the attributes of blockchain applications.

Proposition 2: Fundamental analysis is being harmed by herding.

Proposition 3: Herding has a substantial impact on investing decisions. The properties of blockchain, such as asset transfer efficiency, data correctness, time-stamped transactions, and transparency applications, are proposed to have good effects on fundamental analysis, according to the findings.

Blockchain is a decentralized peer-to-peer network that may be used to incorporate data and instructions in a variety of applications. When investors are able to purchase and sell equities through a decentralized peer-to-peer network that is simple to use and quick, the stock market becomes more efficient.

With the cloud-based management tool (LINQ), the blockchain system records data, and with irreversible, time-stamped transactions, corporate managers will be unable to use techniques such backdating sales contracts prior to reporting period. Due to real-time accounting, manipulation of quarterly results will become less relevant or crucial, which will greatly reduce distortion in enterprises' investment policies. One of the most crucial variables impacting a company's attractiveness to investors is transparency.

When not all investors have the knowledge and sufficient level of financial literacy to conduct their own fundamental analysis in their investment decision making, greater real-time data and information transparency can improve the quality of decision making while stimulating investor participation and market liquidity. Investors may still be prone to psychological biases such as herding tendencies, in which they imitate the actions or decisions of other investors. Although herding increases market liquidity and participation, it also results in emotional, irrational risk-taking investment decisions, which contribute to market failure and crashes.

2.40 Blockchain in education

The essential principles of the blockchain are introduced in this research, with a focus on the educational sector's potential (Grech, Alexander and Camilleri, Anthony F, 2017). It demonstrates how this technology has the potential to both disrupt and empower learners. Based on the present state of technological development and deployment, it proposes eight scenarios for the use of blockchain in education.

Any field of activity based on time stamped record-keeping of ownership titles is expected to be disrupted by blockchain technology. The awarding of qualifications, licensing and accreditation, maintenance of student records, intellectual property management, and payments are all expected to be affected by blockchain technology in education. The use of blockchain in education is relatively new, with only a few peer-reviewed publications in the field. This research is an exploratory look towards blockchain for education, with an emphasis on the state-of-the-art in Europe. Policymakers, educators, strategists, and researchers are the core target audience.

This exploratory study looks at the value that decentralized ledgers, particularly those based on blockchain, can provide to educational stakeholders, with an emphasis on the possibility for digital accreditation of personal and academic learning. At the individual, institutional, group, national, and international levels, blockchain is a technology that obviously has applications in the realm of learning. It is applicable in a variety of settings, including schools, colleges, and institutions, as well as MOOCs, CPD, corporations, apprenticeships, and knowledge bases. When blockchain technology is used to give certificates, it has the potential to improve and add value to the already existing digital certification ecosystem: BADGR and Mozilla Open Badge are already being used to provide digital certifications to students at several major academic institutions.

The goal of notarizing certificates on a blockchain is to turn a digital certificate that a student typically receives privately into an automatically verifiable piece of data that can be consulted by third parties via an immutable proof mechanism on a public blockchain. The concept that people should be able to possess and prove ownership of their vital digital data is at the heart of the blockcerts open standard. These records serve as the foundation for proving aspects of one's identity in accordance with self-sovereign identification principles. In this context, the blockchain is a technology that enables individuals to control their official documents and share them with any third-party for rapid verification, while also preventing any attempt to tamper with or change the information.

The four use cases of blockchain implementation are covered in this research paper:

Use Case 1: The KMI at Open University (OU) is working on a number of blockchain-related research projects. The next generation web, media, augmented reality, smart cities, and analytics are all driving this study focus.

KMI has built a prototype for constructing and issuing micro-credentials on a blockchain, leveraging the potential of Ethereum for accreditation to turn badges into smart contracts. In turn, KMI, Jisc, and the University of Southampton are working together as a node in an international blockchain that also includes the University of Texas, the University of Ghent, and BT.

The integration of the blockchain into the web interface necessitates user training. In this context, blockchain might be viewed as online web interface advancement, akin to Smartphone interface developments. Education wallets, for example, will provide users more control over their data. As a result, user training would be developed at multiple levels, including conceptual, server, and middle management. KMI claims that it hasn't had any concerns with data security or blockchains.

Use Case 2: In its commitment to leveraging the potential of the blockchain in education, the University of Nicosia (UNIC) has claimed a series of "world firsts." UNIC has commissioned its own development team to issue and authenticate certificates using the blockchain, based on the blockcerts open source standard - the company has been working with the MIT Media Lab since 2015. In a web link, UNIC explains how to use a blockchain to issue and authenticate certificates. UNIC is still a member of the blockcerts consortium and a firm believer in open standards, but it is now experimenting with a number of tools to improve the user-facing interface layers.

Use Case 3: The MIT Media Lab began providing digital certificates to groups of people in its broader community using blockcerts in 2015. MIT issued diplomas to two cohorts of students at the MIT Media Lab (Media Arts and Sciences) and the Sloan School of Business using Learning Machine (LM) Certificates, a commercial solution built on blockcerts.

MIT is committed to giving students control over their credentials, but it does not consider its blockchain projects to be prescriptive: students will continue to receive their paper diplomas for the time being. Transcripts are published by MIT using third-party suppliers.

It's quite likely that such vendors would keep an eye on blockchain advances, and it wouldn't be strange to see vertical alliances emerge in the future.

Use Case 4: Since 2016, the Republic of Malta has considered a nation-state pilot on Blockchain in education. Malta's ambitions to be a leader in the blockchain field go beyond education, with the goal of becoming a "blockchain island," comparable to Mauritius and other small or island republics.

2.41 Effect of blockchain in SES (Sharing Economy Services)

Through exploratory research, the authors, (Hilal Artuc, Sathya Vani Kaliannan, 2019) intend to contribute to the Information Systems (IS) sector by investigating the impact of blockchain-based SES from a business model and trust perspective. The findings show that, while blockchain-based SES claim conceptual benefits, they do not have the immediate capacity to disrupt incumbent SES giants in the way they did in the past.

SES (sharing economy services) is a new way of conducting business that matches clients with service providers using cloud-based technology. In this information-intensive services sector, Airbnb, HomeAway, Uber, and Lyft are some of the most successful, well-known, and fastest-growing SES platforms.

The current economic landscape of the sharing economy has silo-like platforms with various drawbacks for users and asset owners, as well as an information asymmetry that may be intentionally exploited by platform owners to collect fees in exchange for providing platforms.

Furthermore, there are growing negative reactions to leading SES companies' business practices on the grounds that they do not reflect the original vision of the sharing economy; rather, the only motivation these companies have is to make money by operating in an unregulated manner and breaking the rules that their competitors must follow.

A peer-to-peer information system based on blockchain technology that connects resource owners and users, with users paying lower or no fees to utilize the platform, is gaining traction. As a result, new organizations have emerged in recent years that have the potential to threaten and/or modify the business models of current technology behemoths that were once deemed disruptive in their market.

The value proposition of these enterprises, which appeals to both service providers and end users, is one of the key incentives for an individual to join in the sharing economy. Because they continue to provide a platform for consumers, blockchain-based SES is replacing traditional platform middlemen with a different kind of intermediate model. “Slock.it”, is one of the businesses that have made use of blockchain and smart contract technologies. This company provides a revolutionary sharing economy platform by automating the contractual process of renting real-world goods (apartments, vehicles, bicycles, washing machines, and so on) on the Ethereum public blockchain.

With a private key maintained by the Slock.it app, users can simply identify usable devices, pay, rent, and utilize them. The company's software, which is based on smart contracts, allows users to open and close a lock, such as a door, bike, or washing machine lock, for a predetermined length of time after the contract's stipulated cost has been paid.

BeeNest is Bee Token's home sharing service, which was created by numerous ex-Uber programmers and dubbed "the future of house sharing." According to Schiller (2018), the website includes similar features to Airbnb, such as the ability to publish appealing photographs, display user ratings and reviews, and define hosting regulations. In contrast to Airbnb and as similar to Slock.it app, there are no fees for hosts to rent out their accommodations.

La'zooz, a real-time ride-sharing software and dubbed the "blockchained Uber," is one of the greatest blockchain apps in the sharing economy and transportation business. The La'Zooz platform, according to the authors, is an open-source, global, decentralized ride-sharing network that will challenge and change existing private transportation networks with enormous numbers of idle vacant seats and cargo space.

2.42 Blockchain in student management system

The student data can be kept on a blockchain network in the Hyperledger architecture, which comprises student and university roles (S.M.K.V. Pramod Kumar, K. Kiran Kumar, R. Sai Krishna, P.S.G. Aruna Sri, 2019). As a pilot advancement for innovation transmitting, this provides a critical Endeavour on the utilization of blockchain innovation to Student-Management involvement. The current Student Management System (SMS) necessitates a standardized assembling process throughout colleges and organizations. Blockchain technology can be used in SMS to avoid tampering with student data, which is critical. With qualities like transparency, immutability, and a distributed manner of keeping records, ledger technology, often known as blockchain technology, paves the door for SMS deployment. Every business has sensitive information that must be safeguarded. The current system, which is centralized storage, requires backups of the data kept in the central server. On the other hand, if data (a file or folder) is modified on the server, the revised file will be accessible to everyone, which must be avoided.

Organizations can use blockchain technology to store data in each system connected to the network. A file cannot be easily updated with this kind of data storage. This technology is mostly used to prohibit third-party members or organizations from participating in a transaction. Cryptocurrencies such as Bitcoin and Ethereum were created with the help of blockchain technology. This might be the future of transactions, with simply the sender and receiver and no third parties involved. Money exchange, certificates, and other types of transactions are examples of transactions. According to the study, a student should have a wallet that carries certificates or information about finished courses. When a student is about to enroll in a higher education institution, that institution must join the network and validate the student's certifications. The 2-2 multi signature procedure is utilized in the validation process. The paper analyses the existing information mismatch between universities and employer firms, as well as the students' incomplete credit system. With the use of blockchain technology, information transparency, authenticity, and applicability may be ensured.

Smooth integration is achieved between students, academic institutions, and employer firms, enhancing educational and employment organizations' use and transparency. Bitcoin, a trustless system, is described in the paper as a blockchain technology application. A peer-to-peer network system is presented for money exchange. There is no need for peers to be recognized, and they can still leave and join the network if they want to. By voting using the peer's CPU, blocks that are transaction records are formally accepted or validated. Any required rules and incentives can be enforced using this consensus approach.

This study presents a blockchain-based system for implementing insurance transaction procedures as smart contracts. The parameters employed during the formation of blockchain should be carefully picked, according to studies, because they have a direct impact on the network's latency. The repository is not encrypted; however it can be encrypted using deep level access control. Every smart agreement would have its own group of validating peers, and this could be expanded to the level of exchanges, with each exchange having its own network of validating peers. The study suggests a system for storing an individual's private information. Foreign entities should not be trusted with private information since they are vulnerable to attack and misuse. Instead, individuals must own and keep ownership of their data without jeopardizing security or limiting enterprises' capacity to provide tailored services. The suggested solution does this through the usage of a blockchain that has been repurposed as an access-control user. Customers do not have to trust foreign businesses, and they are always aware of the data collected about them and how it is utilized. This study proposes a blockchain-based E-auction system that guarantees anonymity, non-repudiation, and immutability of electronic connections. Buyers come in smart contracts for secured orders because of the contract's intricacy, and they may call the erroneous contract function. For example, if the buyer unintentionally calls the reveal function, all auctions are opened, and the auction must be stopped and modified.

The authors of this study proposed a novel information-sharing block chain technology. It has numerous advantages for distribution chain management. When transaction data is prone to misuse, it should not be given to third parties. The suggested platform accomplishes this by merging the blockchain with a more secure encryption method.

Furthermore, the blockchain identifies users as the proprietors of their encrypted data. Organizations or businesses can concentrate on using data rather than thinking about how to manage and compartmentalize it. The authors also offered a system to protect one's identity in the age of social media and online websites, as well as to protect against infiltration, online character abduction, and to provide the person's true public image. A set of hardened smart contracts that can be used to give blockchain-based e-commerce options for small and medium-sized firms that are compatible with one another and a system of identification is also proposed. Companies and entrepreneurs can transition their existing procedures to Syscoin without having to rethink how they function now.

Syscoin is a combination of unique features in a framework that enabled strong security through merged-mining and low inflation, allowing permission less payments and services to be used today in commercial enterprises and enterprises, as well as providing Syscoin token holders with an investment recommendation. A prototype of a decentralized digital content distribution system based on blockchain has been developed.

2.43 Factors underlying blockchain, aimed at the insurance branch

Blockchain has the potential to revolutionize business processes in a variety of industries (Van de Wall, J.P.M, 2017). This study explores the aspects that contribute to the decision-making on good use cases, and it is applied to the insurance branch for this research. The expert system is built using two primary foundations.

The BOAT-model, developed by Grefen, is used to analyze the elements relating to blockchain's technology, business, and architecture domains. The academic foundation on which the technology is examined is Davis et.al Technology Acceptance Model. These models, when combined, provide guidance on how to choose a blockchain use case. In addition, the expert system demonstrates the utility of the use case in three well-known business domains: consolidation, flow transactions, and single source of truth.

It also gives recommendations on the best blockchain platforms, such as Bitcoin, Ethereum, and Ripple. In this current phase of use case exploration, these recommendations help a business choose its best use case. Blockchain is a tool that can be used to help the industry establish transparency and efficiency, or it can be used to undermine the sector's very existence.

Following is an example of a design issue:

Improve the insurance branch's decision-making on blockchain use cases by creating an intelligent tool that can provide an objective analysis of prospective use cases to help understand the elements underpinning the applicability of blockchain and to assist CGI clients in launching a blockchain project. The Wieringa framework is utilized to separate the iterations in their respective phases in order to guide this research to a successful conclusion. Problem investigation, artifact design, and artefact validation are the three phases. Furthermore each iteration is elaborated upon using the information systems research framework of Wieringa.

As a result of the findings, an expert system was developed as an intelligent tool to assist in the resolution of the design challenge and research concerns. The expert system is a model that objectively evaluates a blockchain use case based on the aspects that have been examined and their relationships. The first study topic focuses on the elements that influence the suitability of a blockchain application.

The BOAT-model is utilized as a foundation for the technology's factors. This framework defines the features of a technology-push by defining the domains of business, organization, architecture, and technology. An expert system is offered in this study to aid in the analysis of blockchain use cases. First, the relationships between the blockchain and TAM constructs are investigated. Second, relationships between the blockchain constructs and the platform are developed in order to provide technological guidance. Finally, a link was made between the blockchain constructs and the company clustering strength in order to provide business recommendations. Blockchain is built on the principles of trust, efficiency, openness, and generation. The first indicates a favorable relationship between perceived utility and perceived ease-of-use. Depending on its components, the second displays a positive relationship with perceived utility and a balanced relationship with perceived ease-of-use. Openness has a negative relationship with perceived utility and a good relationship with perceived ease-of-use. Depending on its components, generation is favorably associated to perceived utility and has a balanced relationship with perceived ease-of-use. One of the most crucial parts of successfully implementing a new technology is domain integration. The BOAT framework was chosen to assist in the investigation of intriguing areas.

BOAT, or Business, Organization, Architecture, and Technology, is a paradigm for evaluating technology across diverse domains. This aids in the clarification of various perspectives on technology and the early prioritization of domains.

This decision was made not only to conduct a structured analysis of blockchain characteristics, but also to prioritize those fields and look for logical research gaps. The relationship between the blockchain constructs and the platform construct has been established. The architecture domain's constructs are used to create scenarios that lead to a specific component of the platform construct, such as Bitcoin, Ethereum, or Ripple.

In addition, the expert system has been verified and certified. The verification step revealed one anomaly that was purposefully implemented and has a different purpose. The TAM output looked to demonstrate considerable results throughout the validation phase. As a result, the expert system can be used to solve the provided design challenge.

As a result of this reflection, the frameworks that guided this project are considered critical to its success. The business requirements are extensively investigated, and only the balancing of consultation and insurance, as well as IT and business, can be improved. The TAM and comparable models are recommended as part of an organized literature review on Distributed Ledger Technology. Other points to consider are the validation step, which is simply a preliminary test of the expert system and should be thoroughly tested. In general, an IT consultancy should be able to respond quickly to inquiries about new technology and its potential influence on their clients' businesses. As a result, it is recommended that the evolution of blockchain and other technologies be structurally tracked by specialists working across departments. The number of people involved in this research for data collection or validation is low, and the number of people involved in this research for data generation is considered low to be specifically aimed at a given sector, which is the insurance branch.

2.44 Blockchain in logistics and supply chain

Blockchain is being heralded in Fintech as the silver bullet that will obliterate today's payment processing (Niels Hackius, Moritz Petersen, 2017). The logistics and supply chain management sector is slowly waking up to the potential impact of blockchain on their industry. Authors ran an online survey to gather feedback on use case exemplars, hurdles, facilitators, and the general prospects of blockchain in logistics and supply chain management to throw light on this new topic. The majority of the participants were found to be fairly pleased about this new technology and the benefits it provides. However, factors such as the participants' hierarchical position, blockchain experience, and industry sector have a considerable impact on their opinion. “What would be viable uses for blockchain technology in logistics and SCM?” emerge as the research questions for this study. And “Should blockchain be regarded a treat or a trick in logistics and supply chain management?”

Despite the fact that firms are aware of the potential influence of blockchain on their industry, they appear reticent to devote resources to researching viable blockchain applications. Aside from that, the data offer insight into the viewpoints of various participant groups. Taking into account the participants' hierarchical level, the data reveals that middle managers are less enthused about blockchain than c-level executives or operational personnel.

They give the use cases substantially lower ratings for blockchain benefit and adoption likelihood, envision fewer beneficiaries, and anticipate more showstoppers. Consultants and scientists are concerned about the technological maturity of Blockchain, while logisticians struggle to understand the benefits and application cases. The survey was created with Typeform and consisted of four key sections: The study first enquired about the participants' general knowledge of logistics, supply chain management, and blockchain. Second, they presented the four use case exemplars and asked the audience to rate the benefits of blockchain and the likelihood of adoption. Third, participants were polled on their thoughts on the key beneficiaries of blockchain in logistics, potential adoption impediments, and the predicted impact on existing logistics operations. Finally, information on the job and the company was sought.

The findings emphasize the need of identifying possible logistics and supply chain management use cases. If individuals in a traditionally conservative industry like logistics are expected to adopt new technologies, the benefits must be obvious. Just because something is new doesn't mean logisticians are overly enthusiastic about it. Finally, a report on the current condition of blockchain in logistics and supply chain management is presented.

To answer the first research question about probable blockchain applications in logistics and supply chain management, the authors presented four use case exemplars that are currently being researched in theory and practice. They provided the results of a survey to answer the second study question concerning whether blockchain is a trick or a treat for logistics and supply chain management. The poll looked at the participants' thoughts on use cases, show-stoppers, and benefits of blockchain in the logistics and supply chain management industry.

Blockchain is predicted to have a significant impact on the logistics industry, according to the research, and should be regarded a treat. However, the data indicate that logisticians should begin "chewing" on blockchain as soon as possible. Before someone else does, they should figure out how much of the general blockchain hype can be turned into a value-add for their service portfolio.

2.45 Effects of blockchain implementation on cyber risks

According to (Yasser Mohammed Saadeh, 2018) research looked into the impact of blockchain deployment on cyber risk mitigation techniques, particularly in the UAE's banking industry. Governance, insider dangers, technology, and processes are all highlighted in the research. To obtain data, the quantitative method was employed by designing an online questionnaire.

A printed copy was also given to collect more comments. In this study, ethical considerations were foreseen and taken into account. A total of 149 replies were received, all of which were completed and accepted. The replies were analyzed using the statistical program for social sciences (SPSS) and various analysis techniques such as Cronbach's alpha, correlation test, and regression test.

The findings suggest that blockchain implementation parameters have an impact on cyber risk mitigation measures. The purpose of this research is to assess the impact of blockchain adoption on cyber risk mitigation measures involving governance, insider threats, technologies, and processes.

Board participation, creating a cyber-security plan, and implementing cyber security laws and regulations have all become necessary cornerstones for any firm to protect its investments from cyber-attacks. On the other hand, blockchain's distributed and immutable properties could be crucial in supporting governance factors aimed at minimizing cyber dangers. It is investigated the relationship between blockchain deployment and the governance component. Insider threat can be reduced by a variety of techniques, which can be divided into the following categories: Education and awareness, security culture, and the exchange of sensitive information are all important factors to consider, as a result of the growing number of cyber-threats posed by various technologies. To counteract the consequences of cyber-attacks, a variety of measures are taken. Many governments have begun to develop guidelines for securing and preventing cyber threats to digital services. Furthermore, the majority of firms are implementing security standards or frameworks to identify risks, prioritize them, and assess the maturity of their cyber security practices implementation.

Demographic and employment data testing, descriptive statistics, reliability tests, and correlation and regression tests are among the tests and investigations carried out. The findings of the correlation tests demonstrate that there is a significant positive association between deploying blockchain and cyber risk mitigation factors, hence the null hypotheses are rejected since the results show that blockchain has a major impact on cyber risk factors.

The regression test findings suggest that the regression model has a high degree of goodness of fit and that the variance in cyber risk factors can be explained by applying blockchain. By leveraging the consensus method to authenticate transactions before they can be added to the database, blockchain helps to protect databases and machines from the impacts of DDoS and other ransom ware. Furthermore, blockchain ensures business continuity by ensuring that even if one node fails, the remaining nodes continue to function and the services remain available.

Also, blockchain has a traceable pedigree at its heart. Using blockchain for IoT helps to develop trust between parties while lowering the danger of collusion and rigging. The blockchain technology might be utilized to offer the foundation for IoT security; additionally, the blockchain ledger can be used to store information created by IoT devices, making data flow more orderly and device administration easier.

Furthermore, blockchain technology facilitates the operation of a decentralized IoT network, such as data interchange that is trusted and secure, as well as record keeping. Blockchain technology has the potential to speed up the implementation of transactional data. Furthermore, blockchain has the potential to improve the security of massive data.

On the level of data management and analytics, big data can be coupled with blockchain, allowing the distributed and security properties of blockchain to be used to save essential and critical data. Data failures can be reduced with blockchain-based distributed cloud file storage solutions, which can improve security, privacy, and data control. Using peer-to-peer interactions allows users the ability to control the process of moving and sharing data, as well as sharing internet storage and bandwidth, without relying on intermediaries to do so.

According to the findings, there is a link between blockchain deployment and cyber risk mitigation elements connected to insider threats, such as limiting sensitive information sharing, enabling real-time notifications, and enforcing data authentication. The use of blockchain to automate back office tasks in financial institutions would improve efficiencies while reducing cyber hazards. One of the drawbacks of the blockchain approach is that it minimizes monitoring and control by bypassing legislation, which helps traditional payment networks avoid inefficiencies.

As a result, distributed networks may be less shock-resistant than centralized systems. Standards for blockchain should be set in order to build confidence between end users and technology. Standards could aid in the control of identity threats, authentication of digital identities for financial transactions, in particular.

Furthermore, standards could play an essential role in guaranteeing consistency across diverse blockchain implementations, thus reducing the danger of fragmentation and ensuring the integrity of data transferred. Finally, the conclusions and findings of this study reveal that blockchain deployment and cyber risk mitigation elements have a good link.

2.46 Trust management in social internet of vehicles-blockchain solutions

Internet of Things (IoT) is the next step in the internet's evolution, and it is being realized through the integration of billions of smart objects (Razi Iqbal, Talal Ashraf Butt, Muhammad Afzaal and Khaled Salah, 2019). The use of cutting-edge communication technology has allowed previously isolated gadgets to join the Internet as active participants. This ongoing connectedness opens up new possibilities for new applications, such as the implementation of the social Internet of things and its sub domain, the social internet of cars. In an open and broad social setting, socializing necessitates the sharing of knowledge, which necessitates trust.

The fundamental variables involved in designing an effective trust model for the social internet of vehicles are highlighted in this article. It also focuses on the special issues that come with developing trust models for the social Internet of cars. There are several trust models in the literature; however, most of them are domain-specific, such as Internet of

Things, Social Internet of Things, or generic vehicle networks. This study provides a quick overview of the trust models that could be used in the Social Internet of Vehicles.

Finally, the authors give an outline of how upcoming technologies like as blockchain and fog computing can aid in the development of a trust-based social Internet of cars model for high-efficiency, decentralized architecture, and dynamic nature of vehicular networks.

The understanding of IoV has laid the groundwork for new types of vehicular networks known as the social Internet of vehicles (SIoV) or vehicular social networks (VSN), which have evolved from the parent domain of the social Internet of things (SIoT).

SIoT allows smart things to form and maintain social interactions with one another based on their owners' limitations. SIoV is thus a sub-domain of SIoT in which cars are treated as smart objects. SIoV is a more advanced version of IoV that combines all of the benefits of IoV with the ability to socialize in vehicular networks.

SIoV demands additional resources such as stronger communication protocols, enhanced security and privacy, more storage space, and high processing power in order to provide these added functionalities. The SIoV paradigm promotes employing direct or indirect communication between cars, vehicle components, infrastructure, and drivers' and passengers' portable devices to enable social interactions. Because of the nature of the connection, communication needs, and type of information, vehicle socialization may differ from human socialization.

SIoV's architecture is not standardized, and therefore is vulnerable to hazy interpretations based on existing IoT design. The sensing, network, and application layers of the IoT architecture are simplified, with data collecting, data transfer, and middleware services, respectively. SIoV, on the other hand, is significantly more complicated due to the presence of social interactions and dynamics amongst vehicles. As a result, SIoV necessitates more cognitive and pervasive computing for successful and dependable service delivery.

A mechanism for building a trust connection between entities is trust management. It can be thought of in two ways: as a process of making an entity trustworthy for other entities, and as a process of evaluating the trustworthiness of other entities from the standpoint of a given entity. Trust is an important aspect of socializing, especially in SIoV, because socializing vehicles are often unfamiliar with one another. The ability to recognize risk and uncertainty can be considerably reduced by establishing a trustworthy relationship between the vehicles. The value of confidence varies depending on the situation, even though the participating cars are the same.

Reputation, context, environment, goals, user expectations, social relationships, readiness to connect, and timely evaluation all play a role in SIoV trust. System complexity can be an environmental component in SIoV that affects the trust process between different system entities. The SIoV system should be able to conduct the needed calculations with little intricacy and high efficiency. In a dynamic environment like SIoV, the system's efficiency is directly proportional to its complexity. The overall efficiency of the system can be harmed by adding more complexity. Similarly, in modulation techniques, media access protocols, packet routing algorithms, and services, data transmission must anticipate available standards and industry specifications.

Another external aspect that can affect the system's trust management is the SIoV system's high scalability. As the number of vehicles on the road increases, so do the associated parameters with each system entity, such as messages, sensor readings, relationships, driver, passenger, and pedestrian details, parking slot details, source and destination details, traffic information, traffic signal information, and accident data.

Architectural choices and deployment, Scalability, General reputation and local knowledge, context awareness, social relationships, dependability, privacy, trust-related attacks, heterogeneity and interoperability, quality of service, mobility and unpredictability, and ethics are the main challenges in designing the trust model for SIoV systems.

To summarize, SIoV is a recent development in the field of ITS, that is built on SIoT and cloud-based VANETs. SIoV has a number of undiscovered areas, one of which is the trust model. When it comes to socializing with other units of the system, one of the most important variables is entity trust in one another, and SIoV follows the same approach. The study makes a contribution by outlining the elements that influence the construction of a SIoV trust model. The impact of several aspects on the development of the trust model has been investigated, including reputation, context, environment, goals, expectations, social contact, willingness, and evaluation timeliness.

2.47 Breakthrough of blockchain: Insights from the payments industry

The advent of blockchain technology has sparked a lively debate among scholars and practitioners about the technology's future prospects (Friedrich Holotiuk, Francisco Pisani, Jurgan Moormann, 2018). The potential benefits of blockchain, like other emerging technologies, are frequently at the forefront of discussions. The hurdles that the technology must overcome before breaking through in traditional domains, such as finance, are far less discussed.

The study looked at the influence of blockchain in the payments business, which is a significant pillar of banking and the cradle of blockchain, to reduce this gap and highlight the issues it faces. They did a Delphi research and then a series of specialized interviews to achieve this goal.

The payments industry is an attractive arena for blockchain research due to a number of early blockchain applications and its enormous potential. Payments are also a source of exciting tension for banks. On the one hand, payments are a significant source of revenue for financial institutions in terms of supplying clients with basic and frequently used services. The payments industry, on the other hand, has been the center of a number of developments, such as mobile payment. Payments are also a vital component for gaining access to client data and serve as an anchor product for a variety of other services.

Payment data is a source of information and data on clients, as well as a way to provide points of reference for banks' customers - whether private, business, or institutional. As a result, losing stakes in payment transactions to blockchain firms would be devastating for banks.

Despite blockchain's enormous promise and far-reaching ramifications, its adoption in payments appears to have slowed in terms of speed and intensity. Many existing services could benefit from the technology (for example, by lowering transaction fees and facilitating direct transactions by eliminating intermediaries).

The study performed a Delphi research among specialists in the payments business that is familiar with blockchain technology to identify the problems. The Delphi approach has become a widely used tool for assessing and assisting forecasting and decision-making. It's especially well-suited to developing exploratory theories on interdisciplinary concerns involving new or emerging trends, because it allows for systematic debate of a complicated subject. The Delphi study's data analysis yielded six major issues, according to the authors. These provide a better understanding of the roadblocks to blockchain technology's further development in the payments industry.

The six major challenges are as follows: (1) the need for more practical use cases rather than theoretical concepts; (2) integration within and adaptation to legacy systems; (3) standardization, unification, and interoperability; (4) high availability and robustness; (5) low latency and short response times; and (6) closer collaboration between market players, including regulators.

These appear to be linked and converge on a final point, which is the necessity for the technology to demonstrate its added value in comparison to existing technologies. This is true not only in the payments or financial services industries, but in all other industries as well. In the short term, a shortage of human resources may worsen the current issues, causing the evolution of blockchain to be slowed. Eventually, the attention that technology is currently receiving may help to attract more talent, allowing this problem to be resolved over time.

The need to integrate and adapt the technology with legacy systems is more difficult to overcome, which could be one of the key reasons why existing blockchain use cases do not appear to be convincing. This is partly due to the fact that financial institutions will not be able to entirely restructure their infrastructures anytime soon, particularly given the current economic situation. New rules have already necessitated the installation of extra compliance standards as well as industry-specific modifications, while growing competition and changing customer behavior have depleted necessary resources.

Financial services technologies are the skeleton that supports all activities in a sophisticated economy, and when deployed, they must constantly ensure a reliable and acceptable level of service. As a result, the adoption of blockchain in the payments industry may be postponed until complete guarantee of its reliability is provided. At the same time, the technology may benefit from the industry's stringent criteria. Blockchain has already overcome one of the industry's most significant concerns that of being a single point of failure, due to its peculiarity of being a ledger that is dispersed among the stakeholders in the system. Individual perspectives of blockchain security aspects are extremely varied. Furthermore, security encompasses a wide range of financial services, and the availability and robustness challenge encompasses a variety of factors. Despite the lack of a well-defined concept of reaction time and latency, current blockchain implementations raise concerns about its scalability in terms of the number of transactions that can be processed in a given time frame.

Finally, the study provides evidence about the often lengthy and complicated adoption procedure. It sheds light on the difficulties that blockchain technology, in particular, is thought to be encountering. This study also has crucial practical consequences, as it identifies issues in the financial services industry. It is reasonable to believe that effectively addressing these issues will eventually contribute to the advancement of blockchain technology. The coding of questions throughout the data analysis was done by three different researchers; however it was not double-checked with the panelists to keep the number of Delphi rounds to a minimum.

2.48 Implementation of blockchain technology for agriculture

Food provenance can be tracked using blockchain technology, which aids in the creation of trustworthy food supply chains and the development of trust between producers and consumers (Hang Xiong*, Tobias Dalhaus, Puqing Wang and Jiajin Huang, 2020). It promotes the use of data-driven technologies to make farming smarter by providing a secure means to store data.

Furthermore, when used in conjunction with smart contracts, it enables timely payments between stakeholders that are triggered by data changes in the blockchain. For both theoretical and practical purposes, this research investigates the applications of blockchain technology in food supply chains, agricultural insurance, smart farming, and agricultural product transactions.

The difficulties of tracking smallholder farmer transactions and developing an ecosystem for using blockchain technology in the food and agricultural sector are also explored. For the agriculture sector to boost production and sustainability, it is becoming increasingly important to leverage data and information. In agriculture, information and communication technology (ICT) significantly improves the effectiveness and efficiency of data collection, storage, analysis, and use.

It enables agricultural practitioners and farming communities to acquire up-to-date information quickly and make better judgments in their everyday farming operations. Blockchain is a game-changing technology that has the potential to change the way data is used in agriculture. As a result, the technology gives answers to consumer, government, and industry concerns about food quality and safety. From the point of creation to the point of death, blockchain can track every stage of a product's value chain. For building data-driven facilities and insurance solutions to make farming smarter and less vulnerable, trustworthy data from the farming process is extremely valuable. The crucial data and information on the natural resources that sustain all forms of farming is at the heart of the agri-food systems. Data and information are generated and managed by many actors and stakeholders based on their needs and capabilities.

ICT, the internet of things (IoT), and numerous current data gathering and analysis technologies such as unmanned aerial vehicles (UAV), sensors, and machine learning are all used in smart agriculture. The development of a comprehensive security system that supports the usage and administration of data is a critical aspect of constructing smart agriculture. Traditional data management methods are centralized and vulnerable to inaccuracies, data distortion, and misuse, as well as cyber-attacks. The blockchain technology is used to store data and information generated by numerous actors and stakeholders across the whole value-added process of creating an agricultural product, from seed to sale. It assures that all recorded data is unchangeable and that the data and information are transparent to all involved actors and stakeholders.

Traditional technologies rely on "security of obscurity," but blockchain technology produces security through decentralization. A blockchain is a database that stores time stamped batches of product transactions and activity. Data stored on centrally maintained servers is more prone to loss and distortion than data distributed to Internet-based servers. The database is extremely useful for creating data-driven mobile applications that aid in agricultural optimization.

Furthermore, the blockchain overcomes the difficulty of developing a complete secure IoT infrastructure and integrating a variety of technologies utilized in ICT e-agriculture. The framework's core is a platform that uses blockchain to assist actors creates trust. Agents involved in the production of a product, from seed to sale, can use smart phones to access data stored in the blockchain.

The study presented a blockchain-based ICT e-agriculture model for local and regional use, in which each actor owns a piece of real-time water quality data kept on the blockchain. Farm organizations are also using blockchain to improve their farming practices. Smart agriculture using blockchain does not lessen, if anything, the technological barrier to entry for farmers. Importantly, large farms are more motivated to collect reliable data for uploading to the blockchain than smallholders.

Large farmers are more likely to participate in and benefit from blockchain-based smart agriculture. By publicly giving individual product information in the blockchain, blockchain technology helps manufacturers establish a trust relationship with consumers and build up the reputation of their products.

Businesses can boost their competitiveness by better achieving the value of their products. This would make it difficult for fraud and low-quality product providers to stay in business, and it would force all suppliers in the agricultural and food industries to improve product quality. From the standpoint of consumers, the blockchain provides accurate and trustworthy information about how food is produced and traded. From the point of origin to the retail outlet, blockchain may record information about a product. It allows for the secure and immutable storage of data acquired at the start of the supply chain. To summarize, blockchain technology allows for the traceability of information throughout the food supply chain, which helps to improve food safety. It promotes the creation and deployment of data-driven technologies for smart farming and smart index-based agriculture insurance by providing a secure manner of storing and managing data. Blockchain does not connect with traditional systems in a seamless manner.

2.49 Blockchain based development of a secure and private electronic procurement system

The creation of an online procurement system and the integration of blockchain technology are presented. The graphics, programming logic, and blockchain aspects of the system were designed using a variety of tools including as PHP, JavaScript, HTML, CSS, and jQuery **(**August Thio-ac, Erwin John Domingo, Ricca May Reyes, 2019). Every page and function will have its own structure and outcome. The suggested system's flow of procedure, techniques for testing and hosting the site, and the various web development languages utilized in each step of the development and design process were also presented. Starting with the execution of procurement itself, through the placement of procured things or goods, and on to the signing of contracts by the winner and the procurer, the planned system was successfully and functionally developed. This study shows how blockchain technology works when people receive their health documents via a digital system rather than a paper system.

As a result, the advantages of implementing blockchain technology in an electronic procurement system can be determined. The process and technical components of procurement are represented through numerous mathematical equations with diverse conditions and techniques of procuring commodities and goods, from purchase to declaration of winners.

Electronic procurement will always offer advantages over the traditional paper technique. Integration with blockchain technology may be beneficial, but it will always have limitations. For a platform to be built according to the plan, it requires specialized tools and processes for development, design, documentation, content production, programming, blockchain integration, and online deployment.

The rest of the supply chain will be expected to be faster, more secure, and easier to trace if blockchain is connected with the Internet of Things (IoT). A procurement system's complexity necessitates a well-thought-out technique. The design was created from the beginning to make editing as simple as possible while integrating the blockchain with the programming logic and design. Simple web page layouts were made using HTML and CSS, with jQuery used for triggers and animations.

An online system will never be ideal the first time it is used. Even after the programmers had tested the entire site and its functionality, bugs and faults will always exist. The site's many components were linked after being tested locally and online utilizing local and cloud servers. Even after finishing every file and page on the site, thorough testing was carried out because defects and errors are unavoidable. On our website, every user may encounter some unusual events. Some gadgets are incompatible with the site's scripts and functions, as well as its aesthetics.

Changes and upgrades are inevitable; this is where maintenance and updates are carried out, with old files being replaced and new files being added to ensure the site's compatibility and operation. FileZilla, an FTP client and server software, allows you to effortlessly edit or add files at any time. For the security and safety of user information, as well as the subjects who are associated with the processes of the site's functions, database administration is a top priority.

Finally, three blockchain components – digital signature, multi signature protocol, and blockchain notarization – were used to create a blockchain-based procurement platform. The blockchain platform is only focused on integrating blockchain into the procurement process. The program is restricted to ranking supplier bids based on price. Several private entities were asked to test the platform, with a focus on its blockchain capabilities. Users' responses are collected using an assessment sheet based on their experience with the site. In addition to gathering information from private individuals, four government procurement-related businesses were interviewed. The platform's sophisticated functionalities and scripts concretized the study's goal of creating an immutable system for acquiring goods and services. As a result, the system's capability is restricted to the most basic procurement processes, specifically the announcement of winners based purely on the lowest bid price. Because of the web development languages utilized, certain functionality may fail when using internet browsers other than Google Chrome. The application is primarily reliant on the speed of the users' online connections, which can occasionally fail owing to sluggish internet connections.

The proponents allowed procurement specialists to test the system in order to improve it further. The individuals were then asked for their thoughts on the system and suggestions on how it could be improved further. The proposals centered on improving the interface to increase the platform's user-friendliness, particularly on the market page. In addition, the platform must work with any browser and device. Additionally, automating the Know Your Customer Verification (KYC) process will improve the system's efficiency. The proponents also believe that elements other than the bid price should be included in the proclamation of procurement winners. Finally, there's the distinction between private companies and individual users.

The designed online procurement system included a responsive, aesthetically pleasing website, functional scripts, and sophisticated programming logic and design. The blockchain was integrated into procurement operations from the posting of procured commodities or goods to the signature of contracts between the winner and the procurer. Users may see the account system and personalization of profiles when they sign up and change their profiles. The system is fully functional, up to date, and well-maintained.

2.50 Blockchain based criminal record management system

Criminal records are among the most sensitive types of public information. The validity and rigidity of records may be maintained by putting criminal records into a blockchain, which also helps to keep data safe from enemies (Maisha Afrida Tasnim, Abdullah Al Omar, Mohammad Shahriar Rahman, and Md. Zakirul Alam Bhuiyan, 2018). Data decentralization is possible with a peer-to-peer cloud network. It aids in the prevention of unauthorized data modifications.

This study introduces a criminal record storage system based on blockchain technology, which helps to ensure data integrity and security. It is critical to have accurate and quick access to authentic criminal records in order to implement the law. The impact of corruption on law enforcement will be reduced as well, as this will eliminate the entire spectrum of corruption by eliminating any potential of tampering with criminal records data through strict accountability. One of the government's main responsibilities is to keep track of personal information. Even for modern nations, administering and exploiting these data can be difficult. Different government law enforcement agencies have their own databases, which presents a barrier to data flow between them.

The cost of securing such a large number of databases rises with their number, and the likelihood of illegal alterations rises with it. In today's global context, a good record keeping and information exchange system has become vital due to the expanding number of documents. To maintain national security, law enforcement agencies must communicate with one another and across borders. It's easier to complete the job if you have accurate and time-stamped records. This is where the blockchain technology comes into play.

Because no single entity can manage the peer-to-peer network thanks to the blockchain ledger, the risk of data manipulation is reduced. Furthermore, the blockchain ledger's scattered nature makes it exceedingly difficult to hack, and the chance of information being tampered with is considerably reduced when compared to current systems that rely on traditional digital databases. A decentralized data management approach is used in the suggested system. The system's users are pre-registered. Data senders must first log in to the system. The data is then digitally signed. The system verifies the digital signature to ensure that the data is genuine. The confirmed data is delivered to the cloud data storage after being encrypted with a randomly generated encryption key.

This transaction's metadata is transmitted to the blockchain. The system retrieves the location of this data on the blockchain. The technology then saves critical search factors such as the case number, the offender's name, the passport number, and the national identity number in a local database. The local database also stores the encryption key and the location of the data on the blockchain.

Data receivers must also register with the system. They can then use the aforementioned parameters to search for data. The data is retrieved and decrypted by the system. The system then records the data retrieval event as a transaction on the blockchain and sends the decrypted data to the data recipient. Even if an attacker has the encryption key, they may only be able to examine the data. Data upload requires a valid digital signature from a pre-registered user, so they can't change it. Any update to the data will also be logged as a transaction on the blockchain.

The suggested system keeps track of a person's criminal history. The system's goal is to ensure that the information saved is safe and cannot be accessed or altered by intruders.

Large volumes of data are being kept in databases, making them extremely vulnerable to attacks. Databases may even crash, resulting in data loss. Such issues will not emerge in this system since we use blockchain to keep data transaction logs and encrypt the data so that it cannot be altered. The transaction logs will be duplicated on each node.

The information will be kept in a decentralized cloud system. Data redundancy is increased as a result of decentralization. To encrypt the illegal data, this platform employs the Elliptic Curve Cryptography (ECC) encryption technique. The blockchain stores information about uploads, access, and changes to Cloud data, ensuring security, privacy, and integrity. When dealing with such sensitive data, these security considerations are critical. Courts, select government institutions and people, all police stations, visa application offices, airports, and other entities have access to the information stored by CRAB. From the standpoints of data storage, integrity, privacy, and traceability, the system excludes any human intervention. Our systems' operation is aided by Ethereum-based smart contracts, which make the process of developing and deploying the blockchain straightforward. This also assigns mining tasks to a pre-existing market, lowering costs.

To summarize, public documents are frequently tampered with, and the consequences are generally negative. By utilizing decentralized data storage, this solution eliminates all of these issues. The legitimacy of uploaded material is confirmed by digital signatures. Each data sender is solely responsible for the data's content.

Encryption contributes to the system's security goal. The encryption keys are produced at random, ensuring that no two files have the same key, reducing the danger of assaults tenfold. The data storage and blockchain components of the cloud are not immediately accessible by any user. All of this, taken combined, ensures maximum data security and precise provenance documentation, as well as assisting in the resolution of other potential software/hardware failure concerns.

2.51 Exploration of blockchain based solution for real-estate

Real estate is one of the most important industries in the world, with millions of transactions taking place every day **(**Karan Bhatia, Jivesh Vij, Harshit Kumar, Yogesh

Sharma, Ashish Sharma, 2019). This research examines one prospective blockchain model in the real estate industry, focusing on the norms and regulations in place in India, including the use of AADHAR for verification. This study presents a methodology for implementing blockchain on the real-estate market in India, taking into account government regulations. Every legal real-estate transaction necessitates visits to numerous government offices, appointments, and the maintenance of multiple sets of papers. This is a rather inconvenient process, and it occurred to us that many processes could be automated.

The study created an Automatic Registrar Machine, which is an automated version of a registrar that can perform many tasks that do not require registrar intervention and can be installed in any government office, bank, or other location, reducing the load on a single government office and making the process easier for citizens.

The capacity of blockchain to provide a trustless decentralized platform aids in the removal of numerous intermediaries. The Ethereum Foundation is a non-profit organization dedicated to the development of decentralized Ethereum Virtual Machines. EVM allows us to install blockchains and create Smart Contracts that not only communicate with the current blockchain but also with other blockchains in the network. Real estate is still scarce and unaffected by technology advancements. Many flaws were discovered during a ground property survey of this section. Going to the registrar and other government officials for every transaction is a huge issue. With these concerns in mind, the authors identified main difficulties and a solution model in the following section.

Cases of fraudulent land owner documents, for example, are among the issues that have been identified in the existing real estate system. Even modest transactions, such as a lease or a straight ownership transfer, require appointments and a lot of paperwork. Because all documents are hardbound, government entities have a tough time auditing and tracking transactions. As a result, Indian citizens can only transact during official business days.

Cases of fraudulent land owner documents, for example, are among the issues that have been identified in the existing real estate system. Even modest transactions, such as a

lease or a straight ownership transfer, require appointments and a lot of paperwork. Because all documents are hardbound, government entities have a tough time auditing and tracking transactions. As a result, Indian citizens can only transact during official business days. This smart card would prove to the buyer that he is the rightful owner of the property. The Aadhar verification and block retrieval procedure assures that the card has not been tampered with.

By forming a chain consortium, there will be a limited number of nodes, with the majority of them being automated machines (similar to Automated Teller Machines) that will run a dApp that will allow property owners to conduct various real-estate transactions without the need for human intervention, increasing efficiency and reducing time and paper work for users. After a successful transaction and block formation, tenants are given a slip as proof, and the owner's smart card is updated.

Finally, this proposed system has the potential to be adopted, bringing us one step closer to a clean and green economy. The data is preserved and the transaction is accessed significantly faster thanks to the bit manipulation technology. Many bits have been left out of this system to cover new rules and transaction kinds created by the government. Though this system does not include the financial element, if it evolves towards blockchain, it will be able to fully integrate with the banking business. This would be achievable thanks to blockchain's interoperability. This would be one of the most significant strikes on corruption, terror financing, and a slew of other unethical practices taking place around the world. Using this concept as a foundation record system for vehicles, it is also possible to make pricey products after they have been sold.

2.52 Blockchain-based platform for consent management of personal data processing in the IoT ecosystem

The volume of data generated by devices in the user's environment is constantly expanding in the Internet of Things (IoT) ecosystem, and it is becoming increasingly valuable (Konstantinos Rantos , George Drosatos , Antonios Kritsas , Christos Ilioudis , Alexandros Papanikolaou, and Adam P. Filippidis, 2019). In such a setting, the average user is likely to have significant difficulty comprehending the magnitude and extent of his or her obtained data.

The ADVOCATE platform is proposed in this study as a user-centric solution that allows data subjects to simply manage consents for access to their personal data in the IoT ecosystem. The suggested platform also aids data controllers in meeting GDPR regulations, such as informing data subjects in a clear and unambiguous manner about the data they will manage, the processing purposes, and timeframes.

A blockchain infrastructure protects the integrity of personal data processing consents as well as their immutable versioning control. Processing will be carried out in the IoT ecosystem, particularly in segments such as smart health and smart homes, not only for contractual purposes and to protect the vital interests of the data subject, but also on the basis of users' consents, for data that is not covered by a contract, or where there is no contract.

This is reasonable for makers, sellers, or specialist organizations which may as of now have a legally binding relationship with the information subject yet in addition by outsiders who, without having an authoritative relationship with the information subject, will be extremely quick to access shrewd gadgets for their own business or administrative necessities. In this research, creators present ADVOCATE, a stage that expects to give a climate that works with information regulators' association with information subjects and, all the more significantly, give more control to information subjects on their assents, in accordance with the GDPR necessities.

Specifically, following a client driven way to deal with the advancement of IoT arrangements, this system covers the primary standards of GDPR as indicated by which information regulators will, among others, have the option to advise the client in a straightforward and unambiguous way about any close to home information they are going to oversee and their wellsprings of beginning, the entity(ies) that will interaction it and beneficiaries or classifications of information beneficiaries, any close to home information they are going to oversee and their wellsprings of beginning, the reasons, time spans, and lawful premise of the preparing, the presence of mechanized dynamic, including profiling, as well as could be expected further handling for purposes other than the one for which they were gathered.

Aside from the respectability of assents, blockchain is utilized to guarantee assents forming so the comparing skilled power or an official courtroom will actually want to effortlessly resolve any questions between an information regulator and an information subject as to legal handling of individual information, should the need emerge. The gave permanent forming control recognizes the most recent assents just as periods that particular assents were substantial, in an undisputable way, as the entirety of assents' updates are logged and chronicled information are gotten. Therefore, both the assents' uprightness and legitimacy periods are gotten, accordingly shielding the client from an information regulator and the other way around, which may endeavor to present to the court an adjusted assent or assent that was legitimate during another period.

ADVOCATE addresses the difficulties of privacy protection in the IoT, particularly in relation to permission management, as required by GDPR, and attempts to fill a key void in this area. It allows users to manage their consents and create rules for the disposal of their personal data. Similarly, it gives data controllers a handy tool for complying with GDPR requirements.

The ADVOCATE method requires an IoT ecosystem in which sensors on devices in the user's environment collect and exchange data about the data subject. A smart house, a patient health monitoring system, or activity tracking sensors are examples of such environments. The usage of a portable device, such as a smart phone, is regarded as a critical component since it provides a central point for controlling IoT devices as well as a user-friendly environment for data subjects to engage and manage their personal data disposal policies and consents. It also gives a data controller the tools and a central location to connect with data subjects and collect the appropriate consents. ADVOCATE is a secure cloud-based solution that connects data subjects with data controllers.

It is in charge of conveying data access requests from data controllers and getting the relevant consents from data subjects in a standardized format that ensures interoperability. It is also in charge of upholding the user's policy and safeguarding the consents' integrity and versioning, which will ensure that no unauthorized changes to the consents granted by data subjects are made. Data collected by IoT devices is sent to data controllers either directly or via the user's mobile phone.

ADVOCATE offers the groundwork for developing trust connections between data subjects and controllers in order to create a GDPR-compliant IoT ecosystem. The platform provides an interoperable framework for data controllers to submit user-friendly and unambiguous data access requests and obtain the necessary consents. It also allows data subjects to manage their consents and, as a result, create their own personal data access policy.

The use of digital signatures and the implementation of a consortium blockchain network controlled by the participating data controllers assure the versioning and integrity of consents, a method that reduces deployment costs. Running ADVOCATE on the public blockchain is, as expected, expensive. Furthermore, increasing volumes of consensus PoW algorithms would make running such a service economically untenable. The use of PoA is an alternative solution proposed in this research.

2.53 Announcement effect of blockchain investment on stock prices

The blockchain technology has not only piqued the public's interest, but it has also attracted significant investment from a number of corporations (Yitong Zhou, 2018). The announcement effect is the impact of new information on financial markets. It is one of the most important theories in the field of study. The theory is based on the market efficiency theory, which states that information affects market prices. Many empirical studies show that the announcement of news by a publicly traded company causes a change in its stock price. Good news has a positive impact on the stock market, and vice versa. The timing of the announcement is important; scholars say it is unusual for two announcements in the same category to be released at the same time. As a result, the impact of each event can be expressed as a solo effect.

The announcement has a variety of effects on market prices. When an announcement of external financing is made on the capital market, the firm's market value should rise. Several researchers have investigated the managerial information as one of the plausible explanations for the announcement effect. Managers make decisions based on superior information about market trends and the firm's value. As a result, the information predicts what decision the firm will make. Furthermore, dividend announcements, new investments, and mergers and acquisitions will have an impact on market prices. The blockchain is a new and disruptive technology that has emerged as a result of technological research and development.

There is evidence that the stock price and the R&D announcement have a positive relationship, according to the empirical study of the announcement effect in the R&D sector. The abnormal return on stock price is the primary indicator of the announcement effect. The event study methodology is used to examine the announcement effect of listed companies' blockchain investments. This study primarily concerned with determining whether the announcement of blockchain investment will have an impact on the stock price of the selected listed companies.

There are total seven stages of implementation of the announcement effect which are: 1) Inventory of events, 2) Identification of announcement dates, 3) Data “cleaning” and selecting the final sample, 4) Choosing an event window, 5) Choosing a model for determining the abnormal return, 6) Measuring the impact of the event on stock prices, and 7) Evaluating the significance of the results.

To summarize, the stock price is a good representation of the firm's value. Furthermore, the financial industry is a major player in the development and application of technology. As a result, the study of abnormal returns of financial institutions provides an answer to the question of the blockchain investment announcement effect. An initial research on the empirical study of blockchain technology is presented in this study. Three major benefits of blockchain application in the financial industry attract significantly increased investment. The benefits include increased operational efficiency, cost savings, and increased security and accuracy.

The theories of announcement effect and market efficiency also contribute to the formulation of hypotheses. Announcements of blockchain investment have a positive impact on the stock price of financial companies. The introduction of a new product has no greater impact on stock prices than the start and continuation of a project.

Furthermore, the size effect test indicates that when announcing blockchain investment, small financial firms have a greater impact on their stock prices than large firms.

2.54 Chapter conclusion

After the detail review of literature it can be concluded that the blockchian technology has evolved and revolved in all the possible effective ways. Many researchers have implemented this technology effectively in almost all the domains like finance, retail, agriculture, education, logistics, supply chain, health care etc. It was found that still this technology is not fully accepted so there were certain constraints for not adopting this technology. There were certain factors identified in various domains that led to ignorance of block chain. Every domain had different factors that were categorized into blockchain adoption factors and blockchain diffusion factors. This research aimed at identifying all these factors and further it was tested for specific education domain.

Chapter 3

Research Methodology

3.1 Introduction

This chapter of research methodology begins with explaining the research approach in 3.2 sections. The section 3.3 gives the research background that also covers the proposed model that is tested. Further the sections 3.4, 3.5, 3.6 and 3.7 elaborates the identified research gap, research objectives, research questions and hypothesis. The parameters and constructs that are identified are presented in section 3.9. The process and method of data collection, structure of questionnaire, sample size, population is mentioned in 3.10, 3.11, 3.12 sections respectively. The significance of pilot study implemented and the reliability and validity tests used are described in sections 3.13 and 3.14 respectively. Furthermore the statistical tools used and a brief timeline of research is described in sections 3.15 and 3.16 respectively

3.2 Research approach

Research approaches are research plans and procedures that range from general assumptions to specific data collection, analysis, and interpretation methodologies. The following are three types of research approaches being implemented:

a) Descriptive research

b) Quantitative

c) Exploratory research method

Descriptive research

Descriptive research is a kind of research that is used to explain the traits of a populace. It collects records which can be used to reply to a huge variety of what, when, and the way questions touch on a selected populace or institution. The cause of descriptive research is, of course, to explain, in addition to explain, or validate a few types of speculation or goal on the subject of a selected institution of people. The 3 principal kinds of descriptive research are case research, naturalistic observation, and surveys.

Quantitative research

The process of collecting and interpreting numerical data is known as quantitative research. It can be used to look for patterns and averages, make predictions, test causal linkages, and extrapolate results to larger groups. Quantitative and qualitative data can be collected using a variety of tools. Some of the most often utilized tools are questionnaires, observations, focus groups, and interviews. Quantitative research is divided into four categories: descriptive, correlational, causal comparative/quasi-experimental, and experimental. True experiments are fairly like these types of designs, but there are a few crucial differences.

Exploratory research method

Exploratory research is characterized as research used to analyze an issue which isn't plainly characterized. It is directed to have a superior comprehension of the current issue yet won't give definitive outcomes. Such research is generally done when the issue is at a fundamental stage. Exploratory research studies have three fundamental reasons: to satisfy the specialist's interest and need for more prominent agreement, to test the attainability of beginning a more inside and out study, and furthermore to foster the techniques to be utilized in any after research projects.

There are three kinds of Exploratory research strategies: Secondary research -, for example, assessing accessible writing or potentially information, Informal subjective methodologies, like conversations with customers, representatives, the executives or contenders and Formal subjective exploration through top to bottom meetings, center gatherings, projective techniques, contextual analyses, or pilot contemplates. Some of the more popular methods of exploratory research design include literature searches, depth interviews, focus groups, and case analyses.

3.3 Research background

While research has begun to emerge focusing on blockchain technology, the emphasis has been on the strengths and weaknesses of blockchain as a solution as well as proposals to solve the various technical problems encountered by the technology. Far less has been studied; however, concerning the factors influencing the implementation and application of blockchain within the various themes and uses. In order to achieve this, work must be done in relation to not only the application of blockchain itself but also in relation to its acceptance by consumers. This chapter on research methodology explains the research strategy, research design, and research method employed in this study. It also explains how the chosen research methodology aids in achieving the study objectives and answering the research questions.

On understanding the wider benefits of the blockchain technology and exploring TAM and UTAUT Model, the researcher has proposed a blended interdependence model taking into consideration and combining all the parameters of TAM and UTAUT with context to blockchain technology adoption. The TAM Model consists of four key constructs: Attitude, Perceived Usefulness, Perceived Ease of Use and Intention to Use. The UTAUT model also has four key constructs namely, Performance expectancy, Effort Expectancy, Social Influence and facilitating conditions. The research questions and Hypothesis designed are tested based on this blended interdependence model of TAM and UTAUT. The results have proved that the parameters are pointing towards one entity that is use behavior.

3.3.1 Proposed blended interdependence model

The proposed blended interdependence model is used to:

A. Define new goals and objectives to influence the use of blockchain technology Universities student information system management
B. To understand all dependent and independent factors of TAM and UTAUT

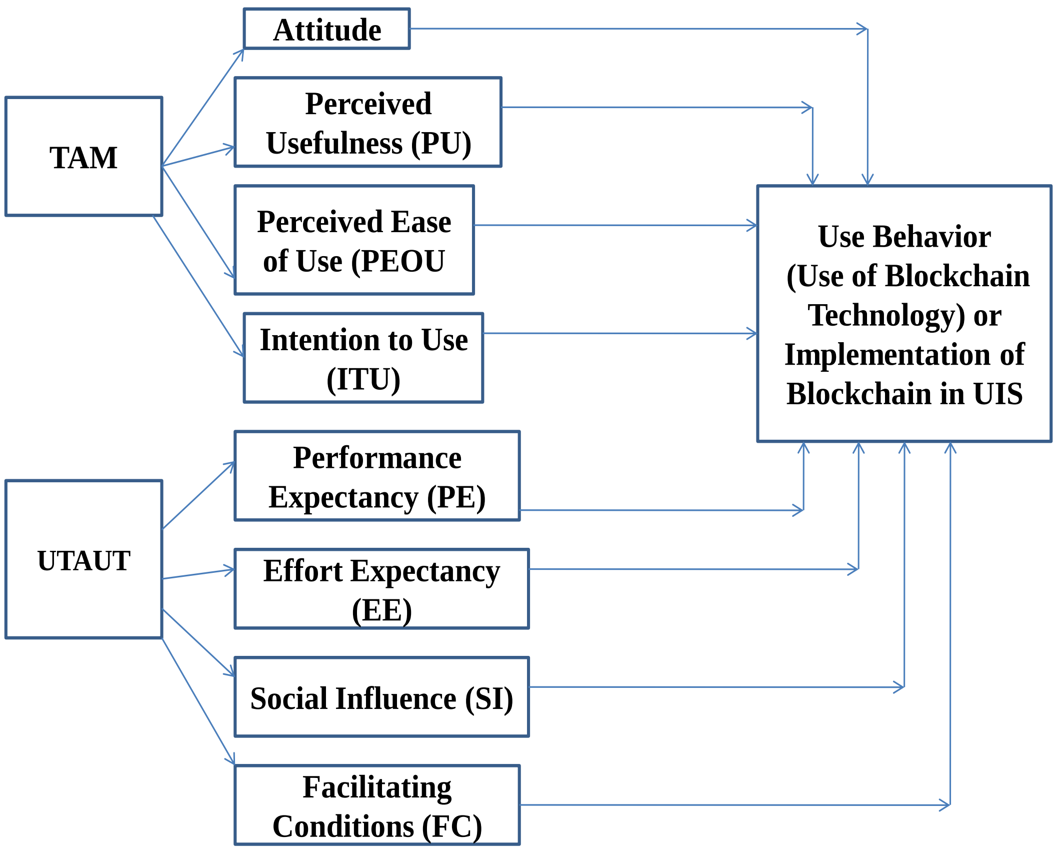


Fig: 3.1 Proposed blended interdependence model

Fig 3.1 shows the proposed blended interdependence model that is a combo model using TAM and UTAUT adoption theories which are implemented to test the use behavior of blockchain ,implementation. Based on the parameters considered, the individual constructs of each TAM and UTAUT adoption theories are correlated, and the combined outcome can be used to analyze the use behavior of adopting the blockchain technology at universities.

3.4 Identified research gap

The literature review shows a predominant focus on blockchain from a technology perspective which emphasizes the need for research into blockchain technology adoption and diffusion. Factors hindering the adoption and diffusion are unidentified in the educational sector. Identifying such factors could accelerate the use of blockchain and its integration into organizations and universities. This problem statement led to the following research question: “Which are the factors that are currently influencing the use of blockchain technology in universities student information system”?

Previous contributions to literature have mainly focused on investigating the technical applications of blockchain in various domains, neglecting the non-technical aspects such as situational factors and functional challenges of use of blockchain technology in educational sector. This may cause the use of blockchain technology to be somewhat neglected from an academic perspective. Having this insight provides the opportunity to identify the factors influencing the use of blockchain technology. This research aims to identify these factors by interviewing the university authorities and employees who are involved in managing the student information system of the universities. Besides the identification of these factors, this research also aims to propose a blended interdependence model that will be used as a guideline for understanding the use of blockchain technology in managing the student information system of any university.

3.5 Research objectives

1. To study the factors that influences the use of blockchain technology in universities student information system.
2. To develop a blended interdependence model using TAM and UTAUT to study use behavior of blockchain technology in universities student information system.
3. To understand the degree of the relationships between the variables of the blended interdependence model.
4. To interpret whether the universities will opt for the blockchain technology for their student information system based on different categories of the demography.
5. To suggest ways to implement blockchain technology in the Universities.

3.6 Research Questions

Following research questions are designed taking into consideration all the elements that cover the functioning of student information system at universities and technology implementation readiness

Q-1: What are the factors that influence the use of blockchain technology in university information system?

Q-2: How are UTAUT model factors related to blockchain technology adoption in university information systems?

Q-3: How are TAM model factors, related to blockchain technology adoption in university information systems?

Q-4: What could be an absolute method to implement blockchain technology in university information system?

3.7 Research Hypothesis

H1: There is a positive correlation between UTAUT and use behavior

H2: There is a positive correlation between TAM and use behavior

H3: There is a significant relationship of TAM with use behavior.

H4: There is a significant relationship of UTAUT with use behavior.

H5: Age of the University and decision to adopt blockchain is not independent of each other.

H6: Number of programs/courses offered by the University and decision to adopt blockchain is not independent of each other.

H7: Strength of the students in the University and decision to adopt blockchain is not independent of each other.

H8: Number of teaching and non-teaching staff of the University and decision to adopt blockchain is not independent of each other.

H9: Years of experience of staff and decision to adopt blockchain is not independent of each other.

3.8 Research process

The research plan is described as follows, starting off by describing the stages of the research process till the implementation of conceptual framework.

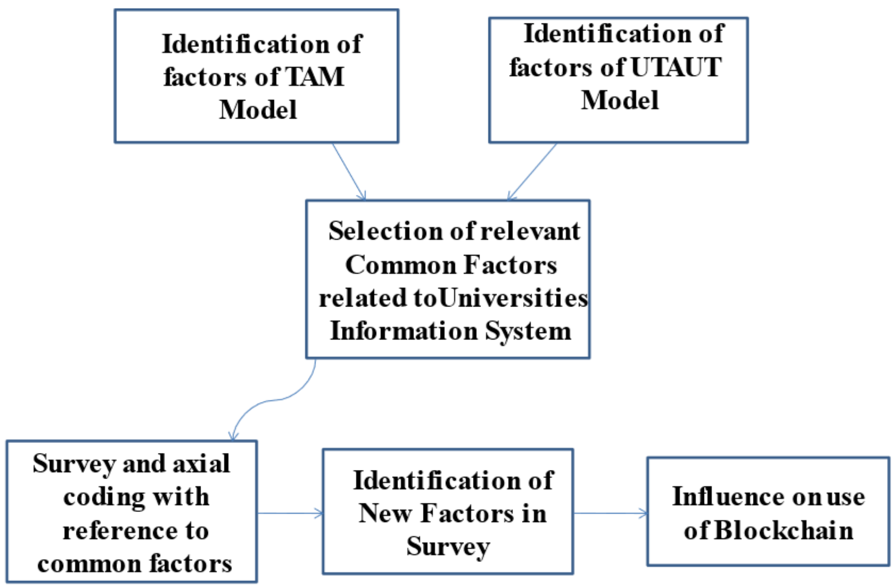


Fig: 3.2 Research process

Research design

Descriptive research has been carried out in this study. The research involves both quantitative and qualitative methods. In quantitative method, both parametric and non-parametric tests have been conducted. Initially parametric tests are conducted to determine the relationship of TAM and UTAUT on use behavior of respondents. The non-parametric tests are conducted to check if the demographic variables and the decision to implement blockchain are independent of each other. In qualitative methods, focused group interviews were conducted with respondents of different Universities to gain more insights on the topic.

3.9 Parameters/Variables/Constructs considered

Based on rigorous literature review, following parameters and sub variables are identified and taking into consideration, these are tested applying TAM (Technology Acceptance Model and UTAUT (Unified Theory of Acceptance and Use of Technology) Model. Table 3.1 defines all the variables/ constructs under various parameters that are identified.

TABLE 3.1 PARAMETERS/VARIABLES/CONSTRUCTS CONSIDERED

Sr. No	Name of Construct	Name of Parameter	Definition
1	Attitude	Attitude	It is a metric for determining whether a complicated combination of factors known as personality, beliefs, values, behaviors, and motivations is valid or correct.
2	Durability	Perceived Usefulness	It refers to a system's ability to survive for an extended period without substantial deterioration.
3	Speed	Perceived Usefulness	It's a metric for how quickly a system runs.
4	Output Quality	Perceived Usefulness	It refers to how well a group of intrinsic qualities meets output criteria.
5	Information Transparency	Perceived Usefulness	It refers to how transparent the system is with the transaction histories
6	Robustness	Perceived Ease of Use	It refers to a system's capacity to continue to function despite defects in its component subsystems or parts.

7	Compatibility	Perceived Ease of Use	It is a system's ability to link things together and make them work.
8	Scalability	Perceived Ease of Use	It's the system's capacity to change available computing resources and scheduling strategies to dynamically alter its own computing performance.
9	User Control	Perceived Ease of Use	The system's ability to aggregate a set of controls into a single, reusable component.
10	System Capability	Performance Expectancy	It is a system's ability to carry out a specific course of action or produce a specific result under a set of conditions.
11	Trust	Performance Expectancy	It is a system's reliance on its own integrity, capability, or character.
12	Immutability	Performance Expectancy	It refers to servers or databases that aren't changed after they've been deployed.
13	Privacy	Performance Expectancy	The right to have some control over how your personal information is gathered and utilized is known as information privacy.
14	Throughput	Effort Expectancy	It is the number of valuable information bits sent by the system per unit of time to a certain destination.
15	System Efficiency	Effort Expectancy	The efficiency of a system is a measure of how well it uses its inputs. The ability to produce something with the least amount of effort is defined as efficiency.
16	Maintenance	Effort Expectancy	It is the ability to sustain the capability of a system to provide a service
17	Viability	Effort Expectancy	It refers to any system that is structured to meet the demands of surviving in a changing environment.

18	Accessibility	Social Influence	Everyone can perceive, comprehend, navigate, and interact with the system if it is accessible.
19	Innovativeness	Social Influence	The method represents a significant shift in how knowledge development is seen and thus encouraged.
20	Good Infrastructure	Facilitating Conditions	Infrastructure is the collection of basic facilities and processes that enable an organization's long-term viability.
21	Regulatory Act	Facilitating Conditions	It's one that's been approved by a group of people based on a law that's previously been passed to ensure adequate data handling and management.
22	Flexibility	Facilitating Conditions	System flexibility refers to the system's capacity to deal with a wide range of products.
23	Standardization	Intension to Use	Standardization refers to the employment of a well-established, time-tested process in the specified system.
24	Developmental Objectives	Intension to Use	It is the process of creating a new software application or program by defining, designing, testing, and implementing it.
25	Disintermediation	Intension to Use	It is the elimination of intermediaries in the data transaction process.
26	Organizational Size	Intension to Use	It refers to the number of employees employed by the company for the purpose of implementing and maintaining the system.
27	Familiarity	Intension to Use	It is an interactive system's capacity to allow a user to transfer earlier experiences, whether real-world or learned through interaction with other systems, onto the features of a new system.

28	Security	Use Behavior/Usage Behavior	It is a procedure for ensuring the system's confidentiality and integrity. When a system's resources are used and accessed as intended under all conditions, it is said to be secure.
29	Latency	Use Behavior/Usage Behavior	It's a time measurement. Latency is the time it takes for data to get across a network to its intended destination.
30	Price Volatility	Use Behavior/Usage Behavior	It relates to a new technological system's pricing changes.
31	Integrity	Use Behavior/Usage Behavior	It is the ability of a system to fulfill its intended purpose without being harmed by unauthorized system modification, whether deliberate or unintentional.

3.10 Method of data collection

The procedure of collecting, measuring, and evaluating correct insights for research using established approved procedures is called as data collection. Based on the facts gathered, a researcher might evaluate their hypothesis. Interviews, direct and participant observations, surveys, and pertinent documents are all examples of data gathering procedures (Saunders et al. (2012). There are a variety of approaches for gathering or obtaining data for statistical analysis. Direct observation, experiments, and surveys are three of the most prominent methods. Gallup polls, pre-election polls, and marketing surveys are examples of surveys that seek information from people.

Qualitative research uses several data collection methods, including observations, textual or visual analysis (e.g., from books or videos), and interviews (individual or group). Interviews and focus groups, on the other hand, are the most employed methodologies, particularly in healthcare research. Quantitative research delivers information in a numerical representation, allowing researchers to assess and comprehend it through statistical analysis. In survey research, the questionnaire is the primary tool for gathering data. It is, in essence, a sequence of standardized questions, sometimes referred to as items, which follow a predetermined format in order to collect individual data on one or more specific themes.

Questionnaires and interviews are sometimes mistaken. Questionnaires are a low-cost, rapid, and effective approach to collect significant amounts of data from a big number of people. Because the researcher is not required to be present while the surveys are completed, data can be obtained fast. Structured and unstructured questionnaires are the two main forms of questionnaires. The quasi-structured questionnaire, which is commonly used in social science research, is a combination of these two. Pre-coded questions are included in structured questionnaires, as are well-defined skipping patterns for following the question sequence.

When it comes to survey response scales, there are three common models to consider: Semantic differential scales; Dichotomous; Rating scales based on the extent to which scale values have the arithmetic features of genuine numbers, there are four types of scales. Order, equal intervals, and a valid zero point are the arithmetic properties. The scale kinds are nominal, ordinal, interval, and ratio, with nominal being the least mathematical and ordinal being the most mathematical. The kind of information within the numbers allocated to variables is described by the level of measurement or scale of measure. The most well-known classification was devised by psychologist Stanley Smith Stevens, who used four levels or scales of measurement: nominal, ordinal, interval, and ratio.

Most experts agree that a 5-point likert scale poll should be used at the very least. However, other study demonstrates that the more options available, the less likely respondents are to choose the center or neutral option. A likert scale is a type of ordered scale in which respondents select the option that best represents their point of view. It's frequently used to gauge people's views by asking how much they agree or disagree with a certain issue or statement. Regardless of the end-point labels, rating scales do not create qualitative data. Quantitative data comes from likert scales and continuous (e.g. 1-5) rating scales. The intervals between points in these scales are assumed to be equal. Likert scales have the advantage of not requiring a simple yes/no response from the respondent, but rather allow for a range of opinions, including no opinion at all. As a result, quantitative data is acquired, implying that the data may be evaluated very quickly. 5-point likert scale is a sort of psychometric response scale in which respondents rate their agreement with a statement on a scale of one to five. (1) agree; (2) disagree; (3) neither agree nor disagree; (4) strongly disagree; (5) strongly agree

For both survey administrators and respondents, the 5-point likert scale is straightforward to learn and use. Higher-point scales need more time and effort to finish. Ordinal scales are always used in likert scales. The intervals between locations on the scale are monotonic, but they are never so well-defined that they can be considered numerically uniform increments. The distinction between ordinal and interval is, however, depends on the unique objectives of the study.

The usual method of reporting on a likert scale is to add the values of each picked choice and give each respondent a score. This number is then used to indicate a certain trait — satisfied or unsatisfied, for example — which is especially useful in sociological and psychological studies. Likert surveys are also a rapid, efficient, and low-cost way to collect data. The likert scale, on the other hand, is one-dimensional, with just 5-7 choices, and the space between each choice cannot possibly be equidistant. As a result, it fails to capture respondents' real feelings. By using the survey-based data collection and analysis, various factors can be identified. The method used in this research is a survey questionnaire for collecting primary data. Data collection and analysis method is adopted wherein questionnaire was circulated amongst authorities and employees who manage student database of various universities across Western India. All the categories of universities are considered which are central, state, deemed and private covering states of western India namely, Maharashtra, Gujrat, Goa, and Rajasthan.

The questionnaire method was chosen among the other methods for several reasons, such as low cost, the time and effort required in gathering data from a large sample, and geographic separation. In addition, in quantitative studies, greater confidence in the outcomes is approved by the structured approach through data collection and analysis, using statistical analysis and a large data sample, which presents a reasonable explanation for the outcomes in a manner that, can be related entirely to others. The survey is managed by the web-based method, telephonic interviews, and personnel interview as well. The questionnaire consisted of objective type and subjective type questions focusing on current student management system and its data maintenance issues, awareness of blockchain and willingness to opt for blockchain etc.

3.11 Structure of questionnaire

The structure of the research questionnaire is shown in Table 3.2.

Table 3.2 Structure of questionnaire

Question Number	**Remark**
Questions 1 to 22	(General Information) Questions based on University Profile and current Data management System
Questions 23 to 26	Questions based on Attitude parameter
Questions 27 to 30	Questions based on Perceived Usefulness parameter
Questions 31 to 34	Questions based on Perceived Ease of Use parameter
Questions 35 to 38	Questions based on Performance Expectancy parameter
Questions 39 to 42	Questions based on Effort Expectancy parameter
Questions 43 to 44	Questions based on Social Influence parameter
Questions 45 to 47	Questions based on Facilitating Conditions parameter
Questions 48 to 52	Questions based on ITU (Intension to Use) parameter
Questions 53 to 56	Questions based on Use Behavior/Usage Behavior parameter

On a 5-point likert scale, the questions were designed to capture the degrees of agreement and disagreement. While conducting interviews, the questionnaire was distributed in both soft copy and hard copy in the form of Google forms. During telephone interviews and personnel interviews, all pertinent questions were asked to the respondents, who were employees who controlled student databases and management members who made decisions about university infrastructure management. Due to COVID-19 pandemic situation very less data collection in physical form was possible. But the approach of the respondents on telephone was appreciable and satisfactory.

3.12 Sample size and sampling technique used

While sample size is one of the major problems, there is no universal agreement on the appropriate sample size. The sample size is calculated using two parameters: (a) the required minimum sample size and (b) the sample size determined by the item ratio issue.

3.12.1 Target population and sample size

Questionnaire in form of Google form was circulated by E-mail to almost 140 universities of western states of India, that state the population size, covering all the universities across the Western India including Maharashtra, Gujrat, Goa, and Rajasthan. Out of the total population, 365 is the sample size considered for the study. The sample size is determined based on the logic: minimum 20 observations for each independent variable taken for the study. In this study, there are eight independent variables. Hence the minimum sample size that can be taken is (20*8) = 160. But the researcher has taken a higher sample size for the study. This is very good indicator to determine the nature of the population as higher sample sizes reduces the effect of multi-collinearity and non-normality.

It was possible to collect data physically in few districts in Maharashtra like Pune, Mumbai, Kolhapur, Sangli, Satara, Solapur, Aurangabad, Nasik, Goa, and few cities from Gujrat. The lockdown restrictions were the main hurdle for data collection. So, the remaining data collection was performed via e-mail and telephonic interviews. Out of the

650 respondents, about 500 responses were received and only 365 responses were shortlisted which were genuine. So, the Sample size is 365

3.12.2 Sampling technique used

The sampling technique which is used is simple random sampling. A simple random sample is a subset of people chosen at random from a larger group, all with the same probability (Kothari, 1985). A basic random sample is created by collecting an exhaustive list of a bigger population and then randomly selecting a particular number of individuals to make up the sample. Every member of the larger population has an equal probability of getting chosen in a basic random sampling.

There are 4 types of random sampling techniques:

- Simple Random Sampling.
- Stratified Random Sampling.
- Cluster Random Sampling.
- Systematic Random Sampling.

The key feature of simple random sampling is that the individual selecting the houses has NO CONTROL over which ones are chosen. The selection is completely random, and each household's pick is unrelated to the choices of other homes. One of the major advantages of the simple random sampling method is that it only requires a basic understanding of the population under study in advance. It is devoid of classification errors.

3.13 Pilot study

Pilot study is an important stage in the research process. The goal of a pilot study is to see if a strategy that will be employed in a bigger study is feasible or not. Both quantitative and qualitative research can benefit from pilot projects. Various researchers recommend that pilot studies have at least 12 participants, with the pr imary goal of estimating average values and variability to organize bigger follow-up studies. Most early-stage investigators can run this size of study at a single center while still getting valuable preliminary data. It's also crucial to test your survey questionnaire before putting it to use for data collection. Pretesting and piloting can help you spot questions that participants don't understand or issues with the questionnaire that could lead to skewed results. Conducting a pilot study does not ensure that the main study will be successful, but it does raise the chances. Pilot studies serve a variety of purposes and can provide vital information to other researchers.

The questionnaire was pilot tested using 50 respondents of the private universities across Pune city. Various category respondents like system analyst, registrar, Head of computer centre, Head of admission cell of various universities were questioned about the university information system management. Data collection was done using an interview technique and Google form. The questionnaire was revised and expanded based on the findings of the pilot test. Because they were members of the interest community, pilot participants were included in the major initiative to collect data. Cronbach Alpha and the confidence interval test were used to assess the questionnaire's reliability. Even though many of the items in this questionnaire have been modified from prior research and have been translated and evaluated by specialists, it still needs to be pilot tested. This technique was used to see if the questions were clear, if they were in the right order, if they captured the idea being studied, if the directions were acceptable, and if there was need to add or eliminate the questions.

Following the pilot study, the final questionnaire was divided into two sections: section one had general information on the university, and section two contained questions about all influencing factors. Two versions of the final questionnaire were created. The first was a Microsoft Word version, which was distributed in hard copy and over e-mail, and the second was a Google form Survey. The word version was printed for hardcopy distribution. Those who were contacted by e-mail were given the option of completing the survey as an attachment or online via a link, while the rest received the survey in hard copy.

3.14 Reliability and Validity test of an instrument

3.14.1 Reliability test

The degree to which a research approach delivers steady and consistent outcomes is known as research reliability. When a measure is used to the same item of measurement multiple times and provides the same results, it is termed trustworthy. In research, trustworthiness is crucial. This is because it verifies that the results are due to the study and not any possible extraneous influences, and it also evaluates if the study achieves its projected goals and hypotheses. Comparing different versions of the same measurement can be used to determine reliability. Validity is more difficult to determine, although it can be evaluated by comparing the findings to other relevant data or theories. Different sorts of methods for estimating reliability and validity are commonly used. Any empirical method or metric can be measured in a variety of ways, including inter-rater reliability, test-retest reliability, parallel forms dependability, and so on.

Test-retest reliability is determined by administering the measure to a group of people once, then administering it to the same group of people again later and comparing the two sets of scores for test-retest correlation. The following is an excellent reliability score: Acceptable dependability is between 0.8 and 0.7. Between 0.7 and 0.6, there is some doubt about the reliability. Poor reliability is said to be in between 0.6 and 0.5. A dependability score of less than 0.5 indicates a lack of trustworthiness.

The researcher chose a pilot study of 50 people from private universities of Pune area to test the research instruments' reliability. Cronbach's Alpha was used to verify the instrument's reliability utilizing internal accuracy procedures. The coefficient ranged between 0.7 and 0.8, indicating acceptable dependability. Cronbach's Alpha was employed to examine the reliability in this study, as it employs item analysis to understand the identity of the items on the survey.

3.14.2 Validity of instrument

The degree to which an instrument measures what it claims to measure is referred to as validity. The questionnaire was well-structured to keep it focused, accurate, and consistent throughout the research. The validity of the research tools was determined by consulting specialists in the field, particularly the researcher's supervisors. The validity of research instruments basically means that the researcher's result is right or truthful. Validity refers to the researcher's questions about whether the measurements are hitting on the construct that the researcher believes they are. While the researcher can obtain specific statistics for reliability of various types, validity is more of a broad assessment based on the evidence available. Content validity, criterion validity, and construct-related validity are the three categories of validity.

3.15 Statistical tools used

Following the reception of the survey responses, an exploratory factor analysis approach is used to examine the validity of the numerous aspects that influence blockchain acceptability. The Cronbach's alpha analysis is performed to verify the data's trustworthiness. The EFA mathematical criterion is then applied to the dataset to generate a factor model. This streamlines the data structure by allowing different objects to be grouped together if they are more efficient under common conditions.

The results have been analyzed using statistical methods. With the use of descriptive statistics, version 22 of the Statistical Package for the Social Sciences (SPSS) was used to evaluate preliminary data and give brief analysis of the study sample such as means, standard deviations, frequencies, and relationships. Multiple regression was used to test the measurement model. The independence of demographic components was determined using Chi-square analysis, and the application of each element is briefly detailed in the analysis.

3.16 Timeline of Research

Research has been completed within given timeline for the research as shown in following table 3.3

TABLE 3.3 TIMELINE OF RESEARCH STUDY

Process	Duration
Literature review	6 months
Structured Interviews & Questionnaire circulation	5 months
Data collection	6 months
Data analysis	5 months
Conclusion and implications	3 months
Writing the thesis	8 months
Amendments and Revisions	2 months

Chapter 4

Data Analysis and Interpretation

4.1 Introduction

The blended interdependence model using TAM and UTAUT is developed to find the use behavior of universities by examining the factors that influences the use of blockchain technology in maintaining university information system. This study focuses on a set of characteristics that influence the use of blockchain technology in the university information system's management. The TAM model is based on new technology adoption on user attitudes, whereas the UTAUT model looks for user intentions to use an information system and subsequent use behavior when adopting new technology. This study focuses on identifying the influencing factors of blockchain technology adoption based on combining and interrelating the variables of TAM and UTAUT that has one common output parameter of use behavior of adoption of new technology.

4.2 Research design

Descriptive research has been carried out in this study. The research involves both quantitative and qualitative methods. In quantitative method, both parametric and non-parametric tests have been conducted. First, parametric tests are conducted to determine the relationship of TAM and UTAUT on use behavior of respondents. Thereafter, non-parametric tests are conducted to check if the demographic variables and the decision to use blockchain are independent of each other. In qualitative methods, focused group interviews were conducted with respondents of different universities to gain more insights on the topic.

4.3 Pilot study

A pilot survey was conducted prior to conducting the main survey with 50 samples to test the reliability and validity of the responses and items included in the questionnaire to proceed further with the actual data collection. The pilot survey aimed to examine whether the proposed model was well designed and adapted to adopt the blockchain technology in the universities. This also looked at how well the survey was structured for respondents to respond correctly to the questions. Based on the results of the pilot survey, the questionnaire was modified, data is collected more systematically. Initially a pilot study with 50 respondents was conducted to check the feasibility of the results. Personal interview has been conducted with the same questionnaire for data collection.

Duration of pilot study: August-2020 till December-2020

4.3.1 Reliability test

Reliability is a measure of the stability or consistency of test scores. It is the ability for a test or research findings to be repeatable. A reliability coefficient is a measure of how well a test measures achievement. It is a proportion of variance in observed scores (i.e., scores on the test) attributable to true scores (the theoretical "real" score that a person would get if a perfect test existed).

The term "reliability coefficient" refers to several different coefficients: Several methods exist for calculating the coefficients include test-retest, parallel forms, and alternate forms. Cronbach's alpha is the most widely used internal consistency coefficients. Value of Cronbach's alpha >0.7, is considered ideal. i.e., the data is reliable. But a value >0.6 is also acceptable is also considered.

If the value of Cronbach's alpha is less, there are different ways to improve it.

i. Increase the sample size
ii. Remove the data with missing values in the data set
iii. Check the output table for alpha if items deleted. Then remove those items from the data set.
iv. Go for resampling

The reliability was tested for four variables with multiple items in each. The variables were Behavior Intention/ Intention to use, use behavior, perceived usefulness, perceived ease of use and perceived risk.

The interpretations of the reliability test are as follows:

1. **Test of reliability for Behavior Intention (BI) /Intention to use**

Table 4.1 a: Reliability statistics for BI

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.588	.555	6

Table 4.1 b: Reliability statistics for BI after reanalyzing

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.622	.625	5

From the above statistic, it is seen in table 4.1 a, that the alpha value is 0.555 which is below the standard. But after removing the first item from the data sheet, and re-analyzing the data, it was observed that the Cronbach's alpha increased to .622 as shown in table 4.2 b, which shows that the data for behavior intension/intention to use is reliable.

2. **Test of reliability for Usage Behavior**

Table 4.2 a: Reliability statistics for Usage Behavior

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.570	.620	11

Table 4.2 b: Reliability statistics for Usage behavior after reanalyzing

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.713	.729	8

From the above statistic in table 4.2 a, it is seen that the alpha value is 0.570 which is also below the standard. Removing the third, fourth and sixth item from the data sheet, the Cronbach's alpha increased to .713 as shown in table 4.2 b, which shows that the data for usage behavior is reliable.

3. **Test of reliability for Perceived Usefulness**

Table 4.3 a: Reliability statistics for Perceived Usefulness

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.659	.672	8

Table 4.3 b: Reliability statistics for Perceived Usefulness after reanalyzing

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.732	.711	6

From the above statistic in table 4.3 a, it is seen that the alpha value is 0.659 which can be taken into consideration for declaring the data as reliable but to improve the result more, item no 2 and 4 were removed and the alpha value increased to .732 as shown in table 4.3 b which is more satisfying to prove that the data for perceived usefulness is reliable.

4. **Test of reliability for Perceived Ease of use**

Table 4.4 a: Reliability statistics for Perceived Ease of Use

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.354	.417	7

Table 4.4 b: Reliability statistics for Perceived Ease of Use after reanalyzing

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.603	.616	3

From the above statistic in table 4.4 a, it is seen that the alpha value is 0.354 which is far below the standard. It required rethinking. But after some trial and error of removing items as per the suggestions given by SPSS, the second, third, sixth and seventh item from the data sheet and leaving only three items behind improved the Cronbach's alpha to .603 as shown in table 4.4 b, which shows that the data for perceived ease of use is reliable.

5. **Test of reliability for Perceived Risk**

Table 4.5 a: Reliability statistics for Perceived Risk

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.278	.314	8

Table 4.5 b: Reliability statistics for Perceived Risk after reanalyzing

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.666	.700	2

From the above statistic in table 4.5 a, it is seen that the alpha value is 0.278 which is also far below the standard. It was observed that most of the items were redundant for the variable mentioned. So, except item second and fourth, all other items were removed. Removing these improved the Cronbach's alpha to .666 as shown in table 4.5 b, which shows that the data for perceived risk is reliable.

4.3.2 Validity

It is not required to consider a suitable instrument solely on the basis of its reliability (Anderson and Gerbing, 1988; Churchill, 1979). As a result, validation of the constructs in this study is required. Validity, according to (Zikmund, 2013), refers to a scale's capacity to calculate what it is designed to calculate. The relationship between a concept and its metrics is known as validity (Punch, 1998). The term "validity" refers to the consistency of a study's findings. According to (Maxwell, 2002), experts have questioned the validity of qualitative analytical studies in terms of trustworthiness. This relates to the precision with which results, policies, and programs can be predicted. If qualitative research fails to meet these standards, the results' dependability will be questioned. According to (Maxwell, 2002), validity refers to evidence, conclusion, and study that are conducted for a specific cause utilizing a method in a specific environment.

Validity issues can be addressed in a variety of ways in both qualitative and quantitative investigations. In contrast to qualitative researchers, quantitative researchers must deal with both anticipated and unanticipated dangers to the validity of their findings. For example, (Maxwell, 2005) argued that qualitative researchers rarely benefit from planned comparisons or sampling methods, or manipulations of statistical data. Researchers will also rule out risks to validity after initiation of the study by developing alternate hypotheses for the evidence gathered. Two significant validity threats have been established (Maxwell, 2005), and are widely associated with qualitative research techniques. Those are:

• Researcher bias-this happens when the data are chosen based on current hypothesis or academic interests of the researcher.

• Reactivity – this is the effect of the environment or individual studies that a researcher may have.

Furthermore, according to (Maxwell, 2005), procedures or methods do not offer validity, but they are important to reduce potential validity-related risks and boost test credibility. For this investigation, the researcher employed secondary data literature, an online expert group, and case study interviews to assist ensure the validity of the findings. According to (Nunnally and Bernstein, 1994), a proper construct contains three important qualities. The construct should thus be considered a suitable representation of the Construction-related measurable domain. Second, alternative methods should include construction. Finally, the structure will be compatible with a variety of other intriguing structures. This thesis examined three types of validity, including substance and construct validity, considering these characteristics (convergent and discriminating validity). Both are connected to the intrinsic validity of the scale as well as their respective objects.

4.3.2.1 Content Validity

The first form to be employed in this analysis is material or face validity. When experts agree that the measure provides adequate coverage of the definition, the measure is said to have face validity (Zikmund, 2003). To obtain material validity, this study follows the procedures recommended by (Cooper and Schindler,1998), which include identifying current scales in the literature and conducting interviews with a panel of experts (including academics and industry practitioners) to obtain their feedback on the instrument. The interviews were conducted as part of the pre-testing methods discussed previously. It is not essential to provide a stricter empirical assessment because the validity of material is subjective in nature (Zikmund, 2003). As a result, it was ensured from the start that the final survey would be used as a guide for other validity tests.

4.3.2.2 Construct Validity

Construct validity is the second category used in this study. It is concerned with what the equipment is measuring (Churchill, 1995). To put it another way, it relates to how well the effects of utilizing the measure that best fits the hypotheses in which the test is built are acquired. (Malhotra, 1996) believed it was also important to address the theoretical problems of why the scales work and what inferences can be drawn from the data. Construct validity (Nunnally, 1967) is not enough, even though measuring reliability and material validity generate in-house consistent sets of measuring objects.

Therefore, in this study, Construct validity was investigated by evaluating both convergent validity and discriminant validity. Convergent validity tests whether the measurements of the same construct are strongly correlated, and discriminating validity decides whether a construct's metrics have not been too closely associated with other constructs (Sekaran, 2000). Several methods for determining convergent and discriminant validity have been proposed, including factor analysis, correlation, and even more complex procedures like as CFA, which are available in SEM. Convergent and discriminating validity were examined using correlation in this study. (Holmes-Smithetal, 2006). The magnitude of the direct structural relationship between the object and the latent construct (or factor) should be statistically different from zero to demonstrate convergent validity. In this analysis, two approaches were employed for discriminant validity. The first method tests the approximate correlations between the variables, which should not exceed .85(Kline, 2005). It is consistent with (Sekaran's, 2000) discriminating validity definition above. That is, if the two variables are strongly correlated (greater than.85), redundant elements are excluded because of a lack of discriminating validity (Kline, 2005). The second method of evaluating discriminating validity tests the pattern structure coefficient to decide if variables are empirically distinct in measurement models. The pattern coefficient is the uniform loading factor resulting from an AMOS analysis. In addition to these restrictive tests of convergent and discriminating validity, construct validity in this study has been improved by ensuring that the model (through goodness-of - fit results obtained from CFA) suits adequately with the data.

4.4 Validity test

Table 4.6 Validity test for Behavior Intention/Intention to use

Correlations

		Behavior Intention / Intention to Use	Behavior Intention / Intention to Use	Behavior Intention / Intention to Use	Behavior Intention / Intention to Use	Behavior Intention / Intention to Use	Total BI
Behavior Intention / Intention to Use	Pearson Correlation	1	.430**	.056	.317*	.134	.539**
	Sig. (2-tailed)		.002	.699	.025	.353	.000
	N	50	50	50	50	50	50
Behavior Intention / Intention to Use	Pearson Correlation	.430**	1	.204	.429**	.182	.744**
	Sig. (2-tailed)	.002		.156	.002	.206	.000
	N	50	50	50	50	50	50
Behavior Intention / Intention to Use	Pearson Correlation	.056	.204	1	.307*	.300*	.623**
	Sig. (2-tailed)	.699	.156		.030	.034	.000
	N	50	50	50	50	50	50
Behavior Intention / Intention to Use	Pearson Correlation	.317*	.429**	.307*	1	.142	.718**
	Sig. (2-tailed)	.025	.002	.030		.324	.000
	N	50	50	50	50	50	50
Behavior Intention / Intention to Use	Pearson Correlation	.134	.182	.300*	.142	1	.515**
	Sig. (2-tailed)	.353	.206	.034	.324		.000
	N	50	50	50	50	50	50
Total BI	Pearson Correlation	.539**	.744**	.623**	.718**	.515**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	50	50	50	50	50	50

**. Correlation is significant at 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 4.7 Validity test for Usage behavior

Correlations

		Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Usage Behavior/ Use Behavior	Total UB
Usage Behavior/ Use Behavior	Pearson Correlation	1	.066	.194	.408**	.044	-.050	.123	.111	.443**
	Sig. (2-tailed)		.648	.177	.003	.761	.731	.394	.441	.001
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.066	1	.373**	.320*	.383**	.206	.392**	-.086	.640**
	Sig. (2-tailed)	.648		.008	.023	.006	.150	.005	.554	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.194	.373**	1	.226	.452**	.187	.405**	.235	.649**
	Sig. (2-tailed)	.177	.008		.114	.001	.194	.004	.100	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.408**	.320*	.226	1	.336*	.094	.315*	.129	.660**
	Sig. (2-tailed)	.003	.023	.114		.017	.515	.026	.372	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.044	.383**	.452**	.336*	1	.492**	.523**	.261	.709**
	Sig. (2-tailed)	.761	.006	.001	.017		.000	.000	.067	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	-.050	.206	.187	.094	.492**	1	.535**	.222	.512**
	Sig. (2-tailed)	.731	.150	.194	.515	.000		.000	.122	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.123	.392**	.405**	.315*	.523**	.535**	1	.154	.704**
	Sig. (2-tailed)	.394	.005	.004	.026	.000	.000		.287	.000
	N	50	50	50	50	50	50	50	50	50
Usage Behavior/ Use Behavior	Pearson Correlation	.111	-.086	.235	.129	.261	.222	.154	1	.332*
	Sig. (2-tailed)	.441	.554	.100	.372	.067	.122	.287		.019
	N	50	50	50	50	50	50	50	50	50
Total UB	Pearson Correlation	.443**	.640**	.649**	.660**	.709**	.512**	.704**	.332*	1
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000	.000	.019	
	N	50	50	50	50	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed). *.Correlation is significant at the 0.05 level (2-tailed).

Table 4.8 Validity test for perceived usefulness

Correlations

		Perceived Usefulness	Perceived Usefulness	Perceived Usefulness	Perceived Usefulness	Perceived Usefulness	Perceived Usefulness	Total PU
Perceived Usefulness	Pearson Correlation	1	.005	.693**	.451**	.344*	.208	.738**
	Sig. (2-tailed)		.975	.000	.001	.014	.147	.000
	N	50	50	50	50	50	50	50
Perceived Usefulness	Pearson Correlation	.005	1	.127	.168	.289*	-.010	.369**
	Sig. (2-tailed)	.975		.380	.242	.042	.947	.008
	N	50	50	50	50	50	50	50
Perceived Usefulness	Pearson Correlation	.693**	.127	1	.672**	.304*	.330*	.840**
	Sig. (2-tailed)	.000	.380		.000	.032	.019	.000
	N	50	50	50	50	50	50	50
Perceived Usefulness	Pearson Correlation	.451**	.168	.672**	1	.420**	.145	.765**
	Sig. (2-tailed)	.001	.242	.000		.002	.314	.000
	N	50	50	50	50	50	50	50
Perceived Usefulness	Pearson Correlation	.344*	.289*	.304*	.420**	1	.213	.664**
	Sig. (2-tailed)	.014	.042	.032	.002		.137	.000
	N	50	50	50	50	50	50	50
Perceived Usefulness	Pearson Correlation	.208	-.010	.330*	.145	.213	1	.448**
	Sig. (2-tailed)	.147	.947	.019	.314	.137		.001
	N	50	50	50	50	50	50	50
Total PU	Pearson Correlation	.738**	.369**	.840**	.765**	.664**	.448**	1
	Sig. (2-tailed)	.000	.008	.000	.000	.000	.001	
	N	50	50	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.9 Validity test for Perceived ease of use

Correlations

		Perceived Ease of Use	Perceived Ease of Use	Perceived Ease of Use	TotalPEU
Perceived Ease of Use	Pearson Correlation	1	.405**	.303*	.819**
	Sig. (2-tailed)		.004	.032	.000
	N	50	50	50	50
Perceived Ease of Use	Pearson Correlation	.405**	1	.338*	.741**
	Sig. (2-tailed)	.004		.016	.000
	N	50	50	50	50
Perceived Ease of Use	Pearson Correlation	.303*	.338*	1	.685**
	Sig. (2-tailed)	.032	.016		.000
	N	50	50	50	50
Total PEU	Pearson Correlation	.819**	.741**	.685**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.10 Validity test for perceived risk

Correlations

		Perceived Risk	Perceived Risk	TotalPR
Perceived Risk	Pearson Correlation	1	.538**	.821**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
Perceived Risk	Pearson Correlation	.538**	1	.923**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
TotalPR	Pearson Correlation	.821**	.923**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

4.5 Interpretation of Reliability test

According to Pearson's critical value or r product moment value, for infinite samples in 0.05 significance level, r value is 0.073. For the variable behavior intension & intension to use, the calculated correlated values are significant. All these values are greater than 0.073(r product moment value) except for the third question. The fifth question of the variable is not significant although the moment product correlation is greater than 0.073. It is advisable for the researcher to either remove these questions or modify the questions. Excepting that the data of behavior intention/intension to use is assumed to be valid.

For the variable usage behavior /use behavior, the calculated correlated values are significant. All these values are greater than 0.073(r product moment value) except second, fifth, sixth question. It is advisable for the researcher to either remove these questions or modify the questions. Excepting that the data of usage behavior /use behavior to use is assumed to be valid.

For the variable perceived usefulness, the calculated correlated values are significant. All these values are greater than 0.073(r product moment value) except second question. It is advisable for the researcher to either remove these questions or modify the questions. Excepting that the data of perceived usefulness to use is assumed to be valid.

For the variable perceived ease of use, the calculated correlated values are significant. All these values are greater than 0.073(r product moment value). Hence the data of perceived ease of use is assumed to be valid.

4.6 Sampling

1. **Population:** The population of the study consists of the faculty and staff working in Universities of Pune. In total 140 universities were taken for study in which approximately, 55000 is the total faculty and staff of the Universities.
2. **Sampling Technique:** The sampling technique used in the study is Simple random sampling where every element of the population has the equal chance of being selected in the sample.

3. **Sample Size:** Out of the total population, 365 is the sample size considered for the study. The sample size is determined based on the logic: minimum 20 observations for each independent variable taken for the study. In this study, there are eight independent variables. Hence the minimum sample size that can be taken is (20*8) = 160. But the researcher has taken a higher sample size for the study. This is very good indicator to determine the nature of the population as higher sample sizes reduces the effect of multi-collinearity and non-normality.

4.7 Data collection process and questionnaire

4.7.1 Data collection process

For data collection, both primary and secondary method has been adopted. In the primary data collection, data has been collected through survey by administering a structured questionnaire. Secondary data has been collected by studying university processes of student management, the existing databases and repository of the students and its administration. University websites are referred to a great extent for the study.

4.7.2 Questionnaire design

The questionnaire distributed for the study consists of 34 Questions. Following are the bifurcation of the questions in each variable.

- 4 questions in attitude.
- 4 questions under perceived usefulness
- 4 questions under perceived ease of use.
- questions under intension to use
- 4 questions under performance expectancy
- 4 questions under effort expectancy
- 2 questions under social influence

- 3 questions under facilitating conditions
- 4 questions under use behavior

All the questions are based on 5-point likert scale (1 being strongly disagree and 5 being Strongly Agree). The entire questionnaire is divided into two sections. The first section is the demographic section; the second section is of two variable clusters TAM and UTAUT consisting of variables. TAM consists of attitude, perceived usefulness, perceived ease of use and intension to use. UTAUT consists of performance expectancy, effort expectancy, social influence and facilitating conditions. And the effect of these variables is observed use behavior.

The questionnaire consisted of six categorical variables. They are as follows:

- Age of the University
- Number of programs/ courses offered by the University
- Approximate strength of the students in the University
- Total number of teaching and non-teaching members
- Total years of experience of the teaching and non-teaching staff
- The decision of the University to implement block chain

Each of these variables has five categories each expect the last one which has two categories i.e. Yes/No.

4.7.3 Administration of the questionnaire

About 650 numbers of questionnaires were distributed. Out of which 500 Responses were received and out of 500, 365 responses were shortlisted which were genuine. The questionnaires were distributed through Google forms.

4.7.4 Variables defined

The variables are defined as follows:

Scales Defined: The data of TAM and UTAUT variables are in interval scale and is measured on a 5-point likert scale (1 being Strongly Disagree and 5 being Strongly Agree).

The data on use behavior is also based on interval scale and is also measured in a 5-point Likert scale. The demographic variables like Age of the University, Number of programs/ courses offered by the University, Approximate strength of the students in the University, Total number of teaching and non-teaching members, Total years of experience of the teaching and non-teaching staff and the decision of the University to implement block chain are all variables in ordinal scale or dichotomous scale.

4.7.5 Data analysis technique implemented

Chi-Square analysis, multiple regression, and correlation were the data analytic tests employed in this study. Chi Square analysis is used to have a comparison between observed values and the expected outcome. Here in this research the expected outcome is the Use behavior of blockchain. Multiple regression technique is used when we have to analyze the significant relationship between one dependent variable and multiple independent variables. The correlation method is implemented when we have to find the linear relationship between any two continuous variables.

The results have been analyzed using statistical methods. With the use of descriptive statistics, version 22 of the Statistical Package for the Social Sciences (SPSS) was used to evaluate preliminary data and give brief analysis of the study sample such as means, standard deviations, frequencies, and relationships. Multiple regression was used to test the measurement model. The independence of demographic components was determined using Chi-square analysis, and the application of each element is briefly detailed in the analysis.

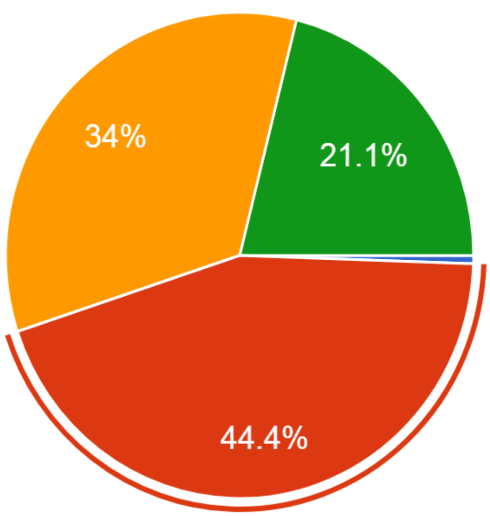
4.8 Statistical analysis and interpretation

4.8.1 Descriptive statistics

The Questionnaire consisted of two kinds of questions; one was general questions wherein the profile and demographic data of university was asked. The second category of questions was based on various parameters and the opinion on a 5-point likert scale was collected. Following shows the interpretation of general questions.

The set of general questions started with the Name, Designation and Name of University. Third general question was about type of university. As there are 4 categories, Central, State, Private and deemed, the respondents responded accordingly.

Type of university



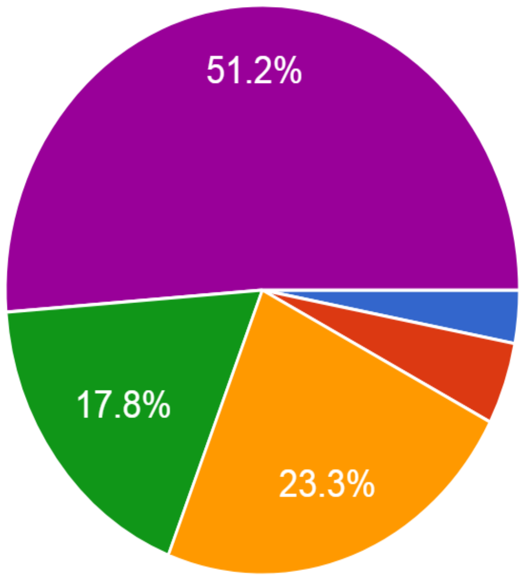
Type of university	
Central	0.5 %
State	44.4 %
Private	21.1%
Deemed	34%

Fig: 4.1 Responses for type of university

Fig 4.1 shows the pie chart of responses over the type of university. The figure shows that 44.4% are state universities, 34% of total are private universities, 21.1% are deemed and only 0.5% are central. The total respondents were 370.

University's age

The next general question asked was about how old the university was. This was asked to have information about the establishment year to analyze the exposure and experience of handling university information system.



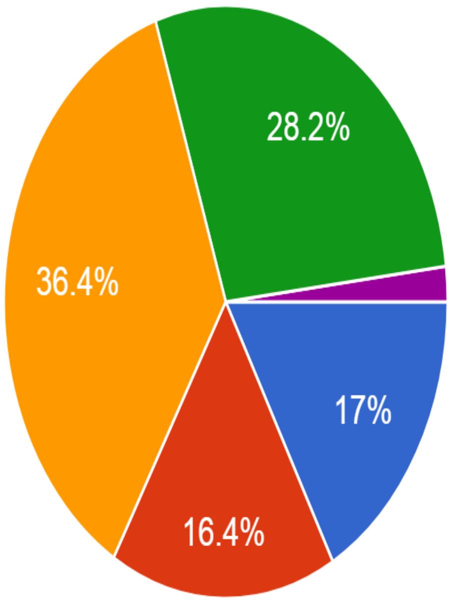
How old is the university?	
Up to 5 years	3.5 %
5 years to 10 years	4.2 %
10 years to 15 years	23.3 %
15 years to 20 years	17.8 %
Older than 20 Years	51.2 %

Fig: 4.2 Responses for university's age

Fig 4.2 shows the pie chart of responses over university's age. The figure shows that 51.2% are older than 20 years; 17.8 % were below 20 years and above 15 years. 23.3 % were below 15 years and above 10 years. The 4.2 % of universities were below 10 years and above 5 years. And 3.5 % were below 5 years.

Number of programs offered by university

This question is considered because to understand the size of the university and variations of courses that helped in analysis of general information management system.



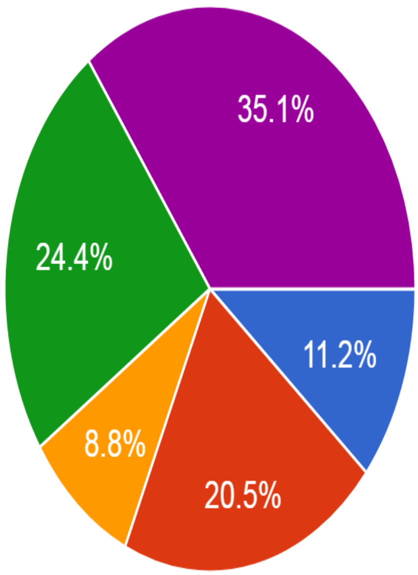
Number of programs offered by university	
Less than 10	17 %
10 to 20	16.4 %
20 to 30	36.4 %
30 to 40	28.2 %
More than 40	2 %

Fig: 4.3 Responses for number of programs offered by university

Fig 4.3 shows the pie chart of responses for number of programs offered by university. The figure shows that 17 % of universities offered less than 10 courses. 16.4 % of universities offered between ranges, 10 to 20. 36.4 % of total universities offered number of courses between the ranges 20 to 30. The 28.2 % of total universities offered the courses between the ranges 30 to 40 and only 2 % of total universities offered more than 40 programs

Strength of student in university

The next general question asked was about how approximate strength of students admitted in the university. This was considered to understand the student count and its data management system to handle the student's record.



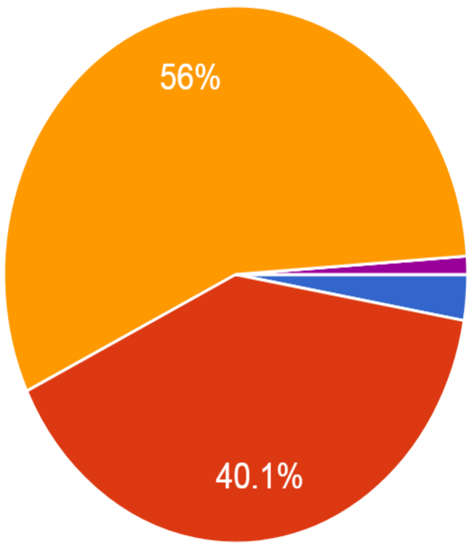
Strength of students in university	
Less than 5000	11.2 %
5000 to 10,000	20.5 %
10,000 to 15,000	8.8 %
15,000 to 20,000	24.4 %
More than 20,000	35.1 %

Fig: 4.4 Responses for approximate strength of students

Fig 4.4 shows the pie chart of responses for approximate strength of students in university. The figure shows that 11.2 % of universities had less than 5000 students. 20.5 % of universities had students admitted in range from 5000 to 10000. 8.8 % of universities have the student strength ranging from 10,000 to 15,000. The 24.4 % of universities had students count between 15,000 and 20,000 and 35.1% of universities had more than 20,000 students admitted.

Total strength of staff in university

This general question was asked to analyze the employee strength that is directly and indirectly involved in handling the student's information system of university.



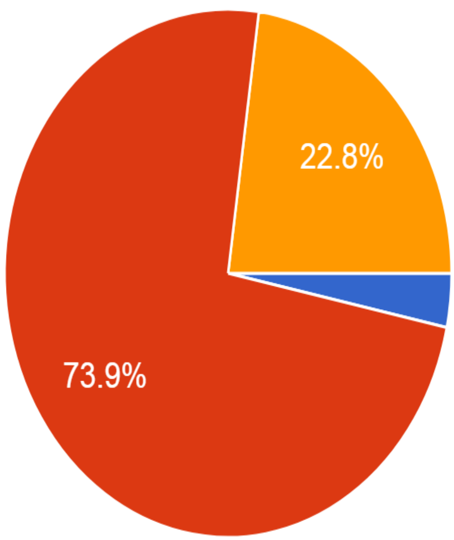
Total strength of staff in university	
Less Than 200	00
200 to 400	40.1 %
400 to 600	56 %
600 to 800	00
More than 800	4 %

Fig: 4.5 Responses for total strength of staff in University

Fig 4.5 shows the pie chart of responses for total strength of staff working in the university which includes both teaching and administrative staff. 56 % of total universities, contained staff count between 400 and 600, 46 % of universities had staff count ranging in between 200 to 400. Only 4 % of universities had the largest count of staff which was above 800. It was observed that no university had staff strength below 200.

Management level of the respondent

The next general question asked was about the positions of the respondent. Generally, the categorization was done in three levels, Top, Middle and Lower. The Vice chancellor, Board of Directors, Chairman was considered the top management authorities. The H.O.D's, controller of Examinations, Assistant Registrars, System Analyst and Tech Support authorities were considered in middle level. All the clerical staff and Technical Assistants were in lower level.



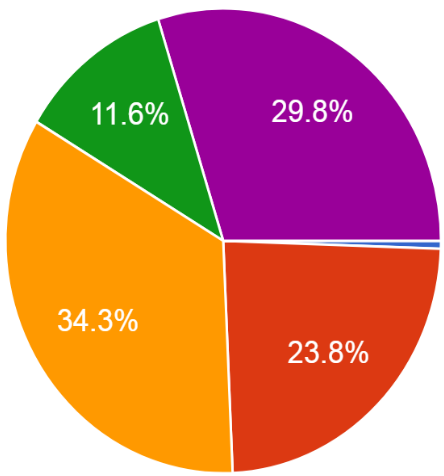
Management level of the respondent	
Lower	3.3 %
Middle	73.9 %
Top	22.8 %

Fig: 4.6 Responses for management level of the respondents

Fig 4.6 shows the pie chart of responses for showing the percentage of management level of the respondents. Amongst the three categories, it was observed that, 73.9 % people belonged to middle level of management, 22.8 % people were from top level management, and only 3.3 % of people were from lower level of management.

University's interaction with external agents (UGC, State Govt. Welfare, Banks etc)

The next general question asked was about, University's Interaction with external agents (UGC, State Govt. Welfare, Banks etc). This also included the MOU's. This was applicable in case of one of the factors of adoption models that pointed towards the dependencies and data transactions with and within the universities.



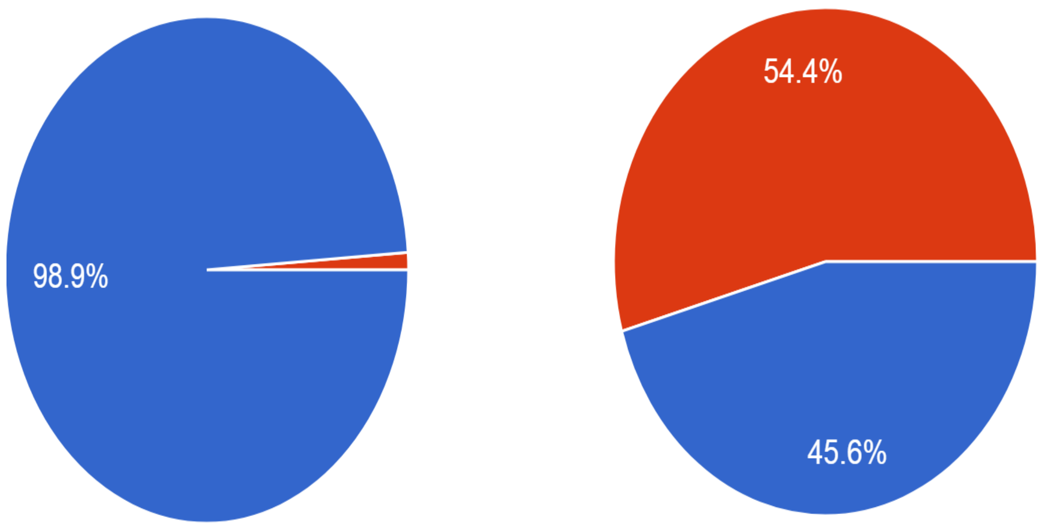
University's interaction with external agents (UGC, State Govt. Welfare, Banks etc)	
Less than 2	30.3 %
2 to 4	23.8 %
4 to 6	34.3 %
6 to 8	11.6 %

Fig: 4.7 Responses for university's interaction with external agents

Fig 4.7 shows the pie chart of responses for universities interaction with external agencies like UGC, State Govt. Welfare, Banks etc. It is observed that 34.3 % of the total universities had MOUs with external agencies in between 4 and 6. 23.8 % of universities interacted with agencies less than 4. The 11.6 % of the total universities interacted with external agencies more than 6 and about on30.3 % universities had MOU's with less than 2 agencies

Use of software/ type of software in universities

The next general question asked was about the usage of any software and type of software by the university to manage student database. This helped in analyzing the exposure of the university towards the types of databases and technical abilities to handle them.



Use of software/ type of software in universities	
Yes	98.9 %
No	1.1 %
Use of custom-built software	45.6 %
Use of standard application	54.4 %

Fig: 4.8 Responses for usage of software and type of software in university

Fig 4.8 shows the pie chart of responses for usage of software and type of software in university. From the pie chart it suggests that 98.9 % of universities use their own software to manage their student record system and only 1.1 % of universities don't use their own software.

The next question was regarding the type of software that was being implemented. Two categories were defined which were, custom built and standard application. The two main categories of application software are general-purpose programs and custom software. Custom software is tailored to a client's individual demands, whereas general purpose programs, sometimes known as off-the-shelf applications, are built as fully featured packages.

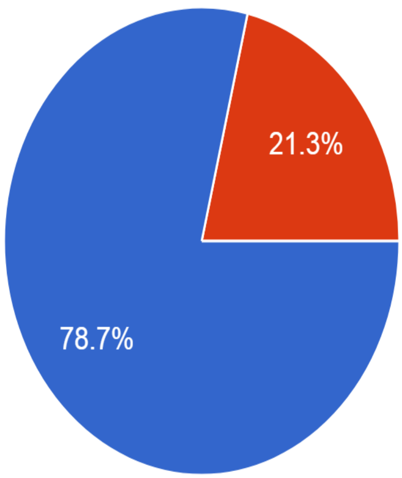
The design of software applications for a specific user or group of users within an organization is known as custom application development. The program integrates seamlessly with any existing corporate software ecosystem, obviating the requirement for different apps to perform certain business operations. You get complete access to the original development team, allowing you to swiftly and effectively fix any difficulties that emerge. Custom software decreases external dangers to your firm since hackers have less incentive to try to break into a system that is only used by one company and there is no public documentation available to shed light on probable attack vectors. You also own the software's intellectual property rights, allowing you to use and improve it as needed even if the original software developer is no longer able to maintain it.

Standard software refers to the operating system and system application software that are required for the general operation of computer servers with the general capabilities of the servers included in the equipment, as updated by any updates made available by the owner of such operating system or systems from time to time.

Fig. 4.8 shows that 45.6 % of universities use the custom-built software and 54.4 % of universities use the standard application software to manage the student's record in the university.

Management of software database

The next general question asked was about the way of managing the software database in the university. Two options were offered, one was within university on –premise and other was over the cloud



Management of software database	
Within university (on Premises)	78.7 %
Over cloud	21.3 %

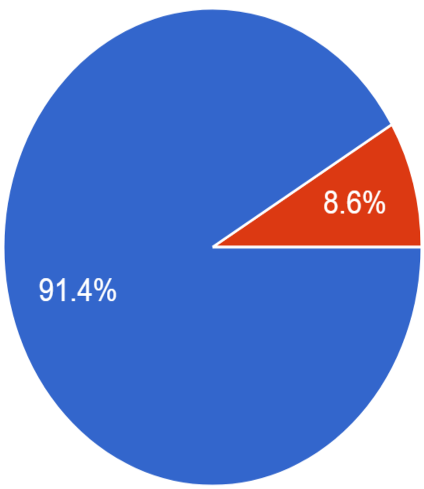
Fig: 4.9 Responses for management of software database

Fig 4.9 shows the pie chart of responses for management of software database. It is observed that 78.7 % of the total universities preferred using the software database within their campus and 21.3 % of the universities used cloud for managing the database.

A cloud database is a database service that is produced and accessible via the internet. It performs many of the same tasks as a traditional database, but with the extra benefit of cloud computing flexibility. To implement the database, users install software on a cloud infrastructure. It allows business customers to host databases without having to purchase dedicated hardware. It can either be handled by the user or offered as a service by a supplier.

Awareness about blockchain technology

The next general question asked was about awareness of blockchian technology and its applications. This was considered as recently through various researches, it is observed that people think block chain technology as restricted to only Bitcoin and trading. To know the depth of understanding about the technology this question was considered.



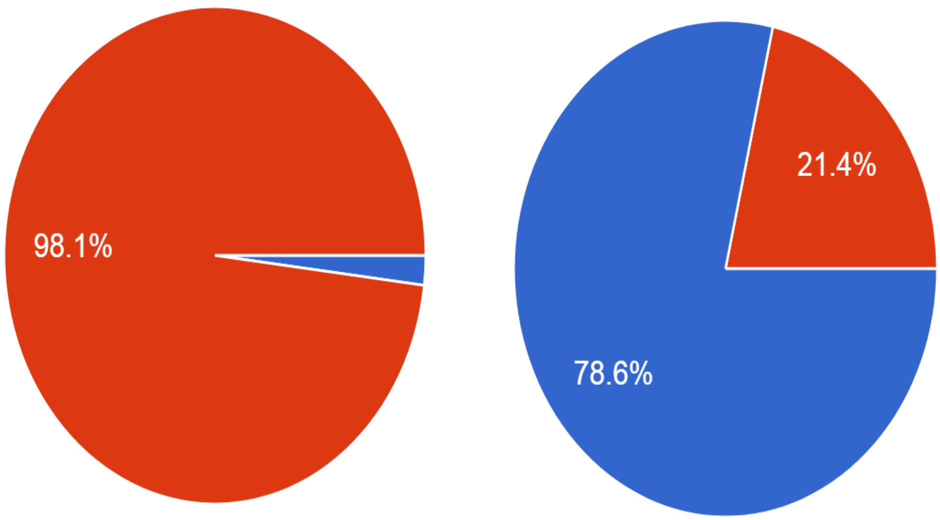
Awareness about blockchain technology	
Yes	91.4 %
No	8.6 %

Fig: 4.10 Responses for awareness about blockchain technology

Fig 4.10 shows the pie chart of responses for understanding the awareness of blockchain technology. The observation was that 91.4 % universities knew that blockchain technology has wider range of applications. Only few, 8.6 % universities were completely unaware about the blockchain technology concept.

Use of blockchain technology/Intend to use of blockchain technology

The next general question asked was about the use of blockchian technology in the university information system. Those who did not use blockchain technology showed willingness to adopt it in near future.



Use of blockchain technology in university	
Yes	1.9 %
No	98.1 %

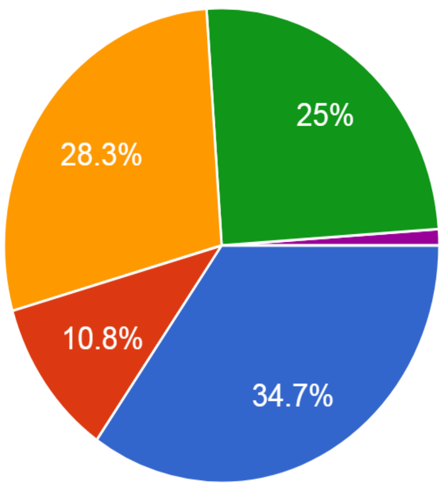
Intend to adopt blockchain technology in university	
Yes	78.6 %
No	21.4 %

Fig: 4.11 Responses for use of blockchain technology/Intend to use of blockchain technology

Fig 4.11 shows the pie chart of responses for usage of blockchain technology and intends to use the blockchain technology for managing student's record in the university. The results show that 98.1 % of the universities are not implementing blockchain technology for managing their student's record. Only 1.9 % of university implements the blockchain technology. Those universities which are not implementing Blockchain opted to go for implementing it in near future. The 78.6 % of universities are willing to adopt blockchain technology and 21.4 % are not willing to go for blockchain technology for managing student's record.

Reason for not adopting blockchain technology

The next general question asked was about the reason behind not implementing blockchain technology in university. Four options were offered, technology readiness, lack of IT trained staff, technology too new to implement and other general reason



Reason for not adopting blockchain technology	
Technology readiness	34.7 %
Lack of IT trained staff	10.8 %
Technology too new to implement	28. 3%
Technology is expensive	25 %
Others	----

Fig: 4.12 Responses for reason for not adopting blockchain technology

Fig 4.12 shows the pie chart of responses for reason for not adopting block chain technology. It is observed that 34.7 % of universities were not ready for exposure of new technology. 10.8 % of universities did not have well trained IT staff and infrastructure. 28.3 % of universities felt that the blockchain technology is too recent to implement and adopt. The 25 % of universities consider blockchain technology to be very expensive.

Overall, most universities today maintain an introvert paradigm, according to the findings. Employees must also adapt mindsets, in addition to the way colleges operate. When a university lacks capacity, it lacks the resources to properly train its workers or invest in new technology.

Universities are apprehensive to invest in blockchain technology, according to five respondents. Few respondents stated institutions may not believe the technology has yet proven itself, are risk-averse, have just invested in new digital infrastructure, or have legacy systems that are preventing the implementation of new technologies. This could also be due to the existing acceptance of blockchain technology by the investing companies or the group/organization in which it is embedded. Before incorporating blockchain technology into your business processes, universities must have a particular level of data quality.

4.8.2 Descriptive statistical calculations

Table 4.11 shows the average and percentage of general descriptive statistical data.

Table 4.11 Average and percentage of general descriptive statistical data

Sr. No	Entity	Total Number	Percentage %
1) Type of university			
a)	Central	2	0.55
b)	State	162	44.38
c)	Private	124	33.97
d)	Deemed	77	21.10
	Total N:-	**365**	**100**

2) Number of Programs/Courses offered			
a)	Less than 10	62	16.99
b)	10 to 20	60	16.44
c)	20 to 30	133	36.44
d)	30 to 40	103	28.22
e)	More than 40	07	1.92
	Total N:-	**365**	**100**
3) Approximate strength of students			
a)	Less than 5000	41	11.23
b)	5000 to 10,000	75	20.55
c)	10,000 to 15,000	32	8.77
d)	15,000 to 20,000	89	24.38
e)	More than 20,000	128	35.07
	Total N:-	**365**	**100**
4) Total number of teaching and non-teaching staff			
a)	Less than 200	10	2.74
b)	200 to 400	146	40
c)	400 to 600	205	56.16
d)	600 to 800	0	0
e)	More than 800	4	1.10

	Total N:-	**365**	**100**
5) Experience			
a)	Upto 5 years	03	0.82
b)	5 years to 10 years	04	1.10
c)	10 years to 15 years	14	3.84
d)	15 years to 20 years	147	40.27
e)	More than 20 years	197	53.97
	Total N:-	**365**	**100**
6) Age			
a)	Upto 30 years	2	0.55
b)	30 years to 40 years	8	2.19
c)	40 years to 50 years	150	41.10
d)	50 years to 60 years	96	53.7
e)	Above 60 years	09	2.47
	Total N:-	**365**	**100**
7) Management level			
a)	Lower	12	3.29
b)	Middle	269	73.70
c)	Top	84	23.01
	Total N:-	**365**	**100**

8) University's interaction with external agents (UGC, State Govt Welfare, Banks, etc)			
a)	Less than 2	2	0.55
b)	2 to 4	86	23.56
c)	4 to 6	124	3.97
d)	6 to 8	44	12.05
e)	More than 8	109	29.86
Total N:-		**365**	**100**

4.9 Data interpretation for likert scale questions

Table 4.12 shows the mean average of parameters under likert scale category

Table 4.12 Mean and standard deviation of variables of TAM and UTAUT

Sr. No	Name of parameter and its sub questions	Mean	S.D
TAM VARIABLES			
I	**Attitude**		
Q-1	Blockchain enabled immutable and distributed data can be a valuable means for managing a student database in a University's information system	4.44	0.64
Q-2	Users connected through a Blockchain enabled information system can view transactions and data related to their system, which gives every user an opportunity to enhance performance in all sense	4.40	0.64

Q-3	Blockchain enabled information systems are based on recent technological standards and it fulfills the need of students, employees, statutory bodies and other stakeholders of University information systems.	4.39	0.65
Q-4	Management support and a positive attitude are important for successful adoption of Blockchain enabled information systems.	4.66	0.47
II	**Perceived Usefulness**		
Q-5	The University information System should be able to withstand the error or damage that occurs during data transactions	4.51	0.5
Q-6	For a better University information System, data access & transaction execution time should be faster	4.60	0.48
Q-7	While executing multiple data handling, the access and tracking of student's data in University information system should occur accurately without any change.	4.49	0.51
Q-8	The data transaction histories should be transparent, so that malicious or unintentional changes can be curbed.	4.58	0.49
III	**Perceived Ease of Use**		
Q-9	Universities that hope to attract students from across the globe need to bring their information system and processes in line with modern student expectation	4.30	0.47
Q-10	The system should allow data sharing and transaction between different networks with different configurations successfully ensuring interoperability and Compatibility.	4.59	0.51
Q-11	The UIS should be scalable in order to handle multiple	4.74	0.43

	transactions without interrupt and error.		
Q-12	Any technology should have the ability to monitor data transaction from a single location or one point of communication.	4.35	0.54
IV	**Intention to use**		
Q-26	The standardization of technology in education system globally allows different inter and Intra stakeholders of education systems to work cohesively in a unique way	4.28	0.46
Q-27	Knowledge and capabilities of employees change organizations view to spot and notice the worth of adopting recent new technology models	3.58	1.36
Q-28	It is found that there is less focus given on back office part of any new technology and more on user interface or user control	3.74	0.91
Q-29	When an organization has high complexity in its structure, IT systems, and decision making, it is harder for them to integrate new technology into their processes because of the required collaboration and coordination	4.53	0.58
Q-30	The use of standard technology ensures fulfillment of requirement of learners, employees, Govt and other stakeholders	3.68	0.88
	UTAUT VARIABLES		
I	**Performance Expectancy**		
Q-13	Student enrollment at Universities is increasing every year. The capability of handling voluminous data of student in existing non distributed and non-mutable	3.56	1.07

	database is not as per the expectation.		
Q-14	The available displayed information of students in University Information System should be trusted by foreign entities.	4.39	0.54
Q-15	The information storage and management needs to be immutable, tracked and secured for long term purpose	4.60	0.49
Q-16	Any new information system should securely allow access to personnel information with prior authorization and permission	4.19	0.64
II	**Effort Expectancy**		
Q-17	The speed of data transaction within a network should be high, independent and unaffected irrespective of unavailability of memory or space	4.57	0.49
Q-18	The use of distributed database technology ensures automatic execution of smart contract that increases the overall performance & efficiency of the system	4.39	0.49
Q-19	The Universities prefer such a UIS which do not involve manual handling of process and require low maintenance	4.24	0.57
Q-20	The structure of new technology must be feasible and should be able to work successfully in spite of all dependent and independent parameters	4.49	0.50
III	**Social Influence**		
Q-21	Many Stakeholders now prefer open source system in their organizations to have good accessibility of records which are declared public	3.94	0.49
Q-22	It if found that the adoption and use of new digital innovation helps in advancement in way of managing and	4.36	0.50

	storing student data at universities		
IV	**Facilitating Conditions**		
Q-23	The use of new technology must be supported by an efficient technical and organizational infrastructure	4.72	0.44
Q-24	There should be some Regulatory Act for protection of valuable information and ownership at Institute level	4.39	0.60
Q-25	The Information System should be flexible in the process of data management	4.72	0.46
USE BEHAVIOUR VARIABLES			
Q-31	University's current technical infrastructure and software systems lack the adequate data protection. It is hard to detect frauds in issuing and storing of transcripts of students	3.50	1.13
Q-32	If the number of intermediaries involved in any data transaction is less and if the technology is self-automated in function, then data is well processed	4.67	0.54
Q-33	The price volatility of new adopted technology of University information System is not significant in comparison to the performance of the system.	3.46	1.55
Q-34	In University information System, the transactions and records must be consistent, accurate and durable once verified	4.78	0.41

4.10 Correlation analysis

Table No- 4.13 Correlation analysis between TAM variables.

Correlations					
		Attitude (TAM)	Perceived Usefulness (TAM)	Perceived Ease of use (TAM)	Intention to use
Attitude (TAM)	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	365			
Perceived Usefulness (TAM)	Pearson Correlation	.260**	1		
	Sig. (2-tailed)	.002			
	N	365	365		
Perceived Ease of use TAM)	Pearson Correlation	.074	.125*	1	
	Sig. (2-tailed)	.059	.017		
	N	365	365	365	
Intention to use	Pearson Correlation	.127	.019	.250	1
	Sig. (2-tailed)	.053	.022	.026	
	N	365	365	365	365
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Interpretation of correlation analysis between TAM variables: From the above table 4.13, it is observed that there is a weak positive correlation between the TAM variables. This is a favorable condition else there would have been multicollinearity between the variables.

Table No- 4.14 Correlation analysis between UTAUT variables

Correlations					
		Performance Expectancy (UTAUT)	Effort Expectancy (UTAUT)	Social Influence (UTAUT)	Facilitating Conditions (UTAUT)
Performance Expectancy (UTAUT)	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	365			
Effort Expectancy (UTAUT)	Pearson Correlation	.249**	1		
	Sig. (2-tailed)	.000			
	N	365	365	365	365
Social Influence (UTAUT)	Pearson Correlation	-.053	.059	1	
	Sig. (2-tailed)	.309	.257		
	N	365	365	365	
Facilitating Conditions (UTAUT)	Pearson Correlation	-.050	.079	.134*	1
	Sig. (2-tailed)	.338	.132	.011	
	N	365	365	365	365
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Interpretation of correlation analysis between UTAUT variables: From table 4.14, it is observed that there is a weak positive correlation between the UTAUT variables. This is a favorable condition else there would have been multicollinearity between the variables. However, it is also seen that there is a weak negative correlation between performance expectancy and social influence and performance expectancy and facilitating conditions.

Testing of Hypothesis

Hypothesis H1: There is a positive correlation between UTAUT and Use behavior

Table No- 4.15 Correlation analysis between UTAUT variables and Use Behavior

Correlations						
		Performance Expectancy (UTAUT)	Effort Expectancy (UTAUT)	Social Influence (UTAUT)	Facilitating Conditions (UTAUT)	Use Behavior
Performance Expectancy (UTAUT)	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	365				
Effort Expectancy (UTAUT)	Pearson Correlation	.249**	1			
	Sig. (2-tailed)	.000				
	N	365	365			
Social Influence (UTAUT)	Pearson Correlation	-.053	.059	1		
	Sig. (2-tailed)	.309	.257			
	N	365	365	365		
Facilitating Conditions (UTAUT)	Pearson Correlation	-.050	.079	.134*	1	
	Sig. (2-tailed)	.338	.132	.011		
	N	365	365	365	365	

Use Behavior	Pearson Correlation	.702	.844	.659	.728	1
	Sig. (2-tailed)	.051	.405	.261	.597	
	N	365	365	365	365	365
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Interpretation of Correlation analysis between UTAUT variables and Use Behavior: From the above table 4.15, it is observed that there is a strong positive correlation between the UTAUT variables and use behavior. In the study, the UTAUT are independent variables, and the use behavior is the dependent variable. Hence there should be a high positive correlation between the independent and the dependent variables. Hypothesis H1 accepted.

Hypothesis H2: There is a positive correlation between TAM and use behavior.

Table No- 4.16 Correlation analysis between TAM variables and Use Behavior

Correlations						
		Use Behavior	Attitude (TAM)	Perceived Usefulness (TAM)	Perceived Ease of use (TAM)	Intention to use
Use Behavior	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	365				
Attitude (TAM)	Pearson Correlation	.643**	1			
	Sig. (2-tailed)	.006				
	N	365	365			

Perceived Usefulness (TAM)	Pearson Correlation	-.724	.260**	1		
	Sig. (2-tailed)	.052	.002			
	N	365	365	365		
Perceived Ease of use (TAM)	Pearson Correlation	.848	.074	.125*	1	
	Sig. (2-tailed)	.048	.059	.017		
	N	365	365	365	365	
Intention to use	Pearson Correlation	.852**	.127	.019	.250	1
	Sig. (2-tailed)	.004	.053	.022	.026	
	N	365	365	365	365	365
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Interpretation of Correlation analysis between TAM variables and Use Behavior: From the above table 4.16, it is observed that there is a strong positive correlation between the TAM variables and use behavior. In the study, the TAM is independent variables, and the use behavior is the dependent variable. Hence there should be a high positive correlation between the independent and the dependent variables. Hypothesis H2 accepted.

4.11 Multiple regression analysis

Assumption Testing: The model of linear regression is considered ideal if it satisfies certain assumptions.

- **Assumption of Scale:** The dependent, the independent variable and dependent variable should be in interval scale. According to the study, all these variables are in interval scale. Hence, this assumption is satisfied.

- **Assumption of Normality of residuals:** The independent and the dependent variables are normally distributed. The residuals are also normally distributed. This is evident from the residual plot and the normal Q-Q plot.

- **Assumption of Multicollinearity:** Independent variables amongst themselves should not be highly correlated with each other. This assumption is tested using Variance Inflation Factor (VIF) values (should not be more than 10 or 5) and Tolerance (should not be < .2). In this study, this condition is satisfied. Hence, there is no multicollinearity amongst the independent variables and the mediating variables.

- **Assumption of Independence:** Residuals should be un-correlated. This assumption is tested by Durbin-Watson in model summary table of regression. The value should lie between 0-4. value near to 2 indicates that residuals are uncorrelated. Value>2, negative correlation and value<2, positive correlation. In this study, the Durbin Watson value is 1.802 which is less than 2 and near to 2. Hence, it is proved that the residuals are uncorrelated.

- **Assumptions of Homoscedasticity:** This assumption states that the variance of error terms is similar across the values of the independent variables. A plot of standardized residuals versus predicted values can show whether points are equally distributed across all values of the independent variables. In the residual plot in this study, it is observed that the residuals almost lie on the regression line. Hence the assumption of homoscedasticity is satisfied.

Regression analysis with assumption testing

Hypothesis H3: There is a significant relationship between TAM and use behavior

Table 4.17 Regression analysis between TAM and Use Behavior

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.212[a]	.045	.034	.571	1.904

a. Predictors: (Constant), Intention to use, Perceived Ease of use (TAM), Attitude (TAM), Perceived Usefulness (TAM)

b. Dependent Variable: Use Behavior

Table 4.18 ANOVA[a] (TAM and Use Behavior)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.500	4	1.375	4.219	.002[b]
	Residual	117.333	360	.326		
	Total	**122.833**	**364**			

a. Dependent Variable: Use Behavior

b. Predictors: (Constant), Intention to use, Perceived Ease of use (TAM), Attitude (TAM), Perceived Usefulness (TAM)

Table 4.19 Coefficients[a] (TAM and Use Behavior)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.592	.513		5.050	.000		
	Attitude (TAM)	.148	.056	.138	2.631	.009	.965	1.036
	Perceived Usefulness (TAM)	-.011	.063	-.009	-.177	.859	.955	1.047
	Perceived Ease of use (TAM)	.051	.068	.039	.753	.452	.975	1.025
	Intention to use	.178	.061	.151	2.928	.004	1.000	1.000

a. Dependent Variable: Use Behavior

Table 4.20 Residuals Statistics[a] (TAM and Use Behavior)

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.72	4.43	4.11	.123	365
Std. Predicted Value	-3.163	2.645	.000	1.000	365
Standard Error of Predicted Value	.047	.121	.065	.015	365
Adjusted Predicted Value	3.67	4.44	4.11	.123	365
Residual	-1.284	1.282	.000	.568	365
Std. Residual	-2.250	2.246	.000	.994	365
Stud. Residual	-2.283	2.284	.000	1.002	365
Deleted Residual	-1.323	1.326	.000	.576	365
Stud. Deleted Residual	-2.296	2.297	.000	1.004	365
Mahal. Distance	1.475	15.274	3.989	2.369	365
Cook's Distance	.000	.036	.003	.005	365
Centered Leverage Value	.004	.042	.011	.007	365

a. Dependent Variable: Use Behavior

Table 4.21 Tests of Normality (TAM and Use Behavior)

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Standardized Predicted Value	.143	365	.200	.943	365	.142
Standardized Residual	.219	365	.200	.894	365	.154

a. Lilliefors Significance Correction

Interpretation: From the regression analysis above, the following interpretation are made.

From the above tables, multiple interpretations are made.

1. The Shapiro-Wilk significant value is >0.05, which proves that the data is normal for TAM and use behavior of block chain are all normally distributed.
2. The standard residual value should vary from -3 to 3. From the table 4.20, of residual statistics, it is seen that the value is lying in between the acceptable range. This concludes that the residuals are normally distributed.
3. The value of Durbin Watson is 1.904 which has a value near to 2, implies that the residuals are un-correlated. This satisfies the assumption of independence.
4. From the model summary table 4.17, it is observed that the R square is .045, which implies that the independent variables explain the dependent variable to 4.5%.
5. From the ANOVA table 4.18, it is observed that the F (4,360) = 4.219, MSE = 1.375, p = 0.002 <0.05 implies that the null hypothesis (H0) is rejected, and the alternative hypothesis (H3) is accepted. i.e., overall, there is a significant impact of TAM on use behavior forblock chain. From the coefficient table 4.19, the actual value of Y (use behavior), following the equation,

   Use behavior for blockchain= a + b1 (Attitude) + b2 (PU) + b3 (PEoU) + b4 (IU)
   Use Behavior = 2.592 +.148 (Attitude) -.011(PU) + .051(PEoU) + .178(IU)
6. Hypothesis H3 accepted.

Hypothesis H4: There is a significant relationship between UTAUT and use behavior

Regression Analysis between UTAUT and Use Behavior

Table 4.22 Model Summary[b] (UTAUT and Use Behavior)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.124[a]	.015	.004	.580	1.950

a. Predictors: (Constant), Facilitating Conditions (UTAUT), Performance Expectancy (UTAUT), Social Influence (UTAUT), Effort Expectancy (UTAUT)
b. Dependent Variable: Use Behavior

Table 4.23 ANOVA[a] (UTAUT and Use Behavior)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.891	4	.473	1.407	.231[b]
	Residual	120.942	360	.336		
	Total	122.833	364			

a. Dependent Variable: Use Behavior
b. Predictors: (Constant), Facilitating Conditions (UTAUT), Performance Expectancy (UTAUT), Social Influence (UTAUT), Effort Expectancy (UTAUT)

Table 4.24 Coefficients (UTAUT and Use Behavior)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std.Err	Beta			Tolerance	VIF
1	(Constant)	2.463	.810		3.042	.003		
	Performance Expectancy (UTAUT)	.179	.094	.104	1.912	.057	.929	1.076
	Effort Expectancy (UTAUT)	.018	.081	.012	.229	.819	.926	1.080
	Social Influence (UTAUT)	.155	.136	.061	1.144	.253	.976	1.025
	Facilitating Conditions (UTAUT)	.047	.104	.024	.451	.652	.973	1.028

a. Dependent Variable: Use Behavior

Table 4.25 Residuals Statistics[a] (UTAUT and Use Behavior)

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.72	4.46	4.11	.072	365
Std. Predicted Value	-5.368	4.923	.000	1.000	365
Standard Error of Predicted Value	.035	.194	.060	.032	365
Adjusted Predicted Value	3.68	4.49	4.11	.073	365
Residual	-1.291	1.070	.000	.576	365
Std. Residual	-2.227	1.846	.000	.994	365
Stud. Residual	-2.261	1.904	.000	1.001	365
Deleted Residual	-1.331	1.149	.000	.584	365
Stud. Deleted Residual	-2.274	1.911	.000	1.004	365
Mahal. Distance	.298	39.947	3.989	6.138	365
Cook's Distance	.000	.062	.003	.006	365
Centered Leverage Value	.001	.110	.011	.017	365

a. Dependent Variable: Use Behavior

Table 4.26 Tests of normality (UTAUT and Use Behavior)

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Standardized Predicted Value	.325	365	.000	.670	365	.080
Standardized Residual	.285	365	.000	.815	365	.120

a. Lilliefors Significance Correction

Interpretation: From the regression analysis above, the following interpretation are made.

From the above tables, multiple interpretations are made.

1. The Shapiro-Wilk significant value is >0.05, which proves that the data is normal for UTAUT and use behavior of blockchain are all normally distributed.
2. The standard residual value should vary from -3 to 3. From the table 4.25 of residual statistics, it is seen that the value is lying in between the acceptable range. This concludes that the residuals are normally distributed.
3. The value of Durbin Watson is 1.950 which has a value near to 2, implies that the residuals are un-correlated. This satisfies the assumption of independence.
4. From the model summary table 4.22, it is observed that the R square is .015, which implies that the independent variables explain the dependent variable to 1.5%.
5. From the ANOVA table 4.23, it is observed that the F (4,360) = 1.407, MSE = .473, p = 0.231>0.05 implies that the null hypothesis (H0) is accepted, and the alternative hypothesis (H4) is rejected. i.e., overall, there is no significant impact of UTAUT on use behavior for blockchain. From the coefficient table 4.24, the actual value of Y (use behavior), following the equation,
   Use behavior for blockchain= a + b1 (PE) + b2 (EE) + b3 (SI) + b4(FC)
   Use Behavior = 2.463 +.179 (PE) +.018(EE) + .155(SI) + .047(FC)
6. Hypothesis H4 rejected.

4.12 Chi Square test

The Chi-square test is performed to test the association between the categorical variables. It is considered as a non-parametric test. It is mostly used to test statistical independence.

Hypothesis H5: Age of the University and decision to adopt blockchain is not independent of each other.

Table 4.27 Case processing summary for H5

	Cases					
	Valid		**Missing**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
How old is the University? * If no, does your University have any plans to go for using Blockchain?	365	100.0%	0	0.0%	365	100.0%

Table 4.28 Crosstabulation for H5

How old is the University? * If no, does your university have any plans to go for using Blockchain? Crosstabulation

Count

		If no, does your university have any plans to go for using Blockchain?		Total
		Yes	No	
How old is the University?	upto 5 years	6	5	11
	5-10	11	6	17
	10-15	71	14	85
	15-20	54	11	65
	older than 20 years	147	40	187
Total		289	76	365

Table 4.29 Chi Square test for H5

Chi-Square tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	7.820[a]	4	.098
Likelihood Ratio	6.926	4	.140
Linear-by-Linear Association	.954	1	.329
N of Valid Cases	365		
a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 2.29.			

Interpretation: From the cross-tabulation table 4.28, it is observed that the Universities that are established recently are not willing to adopt blockchain technology. Whereas the Universities are old enough i.e., more than 15 years old are highly willing to implement blockchain technology in their system. From the Chi-square test table 4.29, it is observed that the significant value of Pearson's Chi-square test is 0.098 > 0.05. So, the null hypothesis is accepted, and alternate hypothesis (H5) is rejected. Hence, it is interpreted that Age of the University and decision to adopt blockchain is independent of each other.

Hypothesis H6: No of programs/courses offered by the University and decision to adopt blockchain is not independent of each other.

Table 4.30 Case processing summary for H6

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Number of Programs/Courses offered * If no, does your university have any plans to go for using Blockchain?	365	100.0%	0	0.0%	365	100.0%

Table 4.31 Crosstabulation for H6

Number of Programs/Courses offered * If no, does your university have any plans to go for using Blockchain? Crosstabulation				
Count				
		If no, does your university have any plans to go for using Blockchain?		Total
		Yes	No	
Number of Programs/Courses offered	Less than 5	24	38	62
	5-10	44	16	60
	10-15	117	16	133
	15-20	98	5	103
	More than 20	6	1	7
Total		289	76	365

Table 4.32 Chi-Square tests for H6			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	85.178[a]	4	.000
Likelihood Ratio	77.598	4	.000
Linear-by-Linear Association	71.561	1	.000
N of Valid Cases	365		
a. 1 cells (10.0%) have expected count less than 5. The minimum expected count is 1.46.			

Interpretation: From the cross-tabulation table 4.31, it is observed that the Universities that are running 15-20 or less than 15-20 courses or programs are highly inquisitive for implementing blockchain technology. Universities with more than 20 courses/ programs did not show their keen interest for blockchain. From the Chi-square test table 4.32, it is observed that the significant value of Pearson's Chi-square test is 0.000< 0.05. So, the null hypothesis is rejected, and alternate hypothesis (H6) is accepted. Hence, it is interpreted that No of programs/courses offered by the University and decision to adopt blockchain is dependent on each other.

Hypothesis H7: Strength of the students in the University and decision to adopt blockchain is not independent of each other.

Table 4.33 Case processing summary for H7

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Approximate Strength of Students in the University * If no, does your university have any plans to go for using Blockchain?	365	100.0%	0	0.0%	365	100.0%

Table 4.34 Crosstabulation for H7

Approximate Strength of Students in the University * If no, does your university have any plans to go for using Blockchain? Crosstabulation

Count

		If no, does your university have any plans to go for using Blockchain?		Total
		Yes	No	
Approximate Strength of Students in the University	Less than 1000	14	27	41
	1000-5000	51	24	75
	5000-10000	27	5	32
	10000-15000	76	13	89
	More than 15000	121	7	128
Total		289	76	365

Table 4.35 Chi Square test for H7

Chi-Square tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	77.026[a]	4	.000
Likelihood Ratio	70.734	4	.000
Linear-by-Linear Association	66.143	1	.000
N of Valid Cases	365		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.66.			

Interpretation: From the cross-tabulation table 4.34, it is observed that the Universities that have a greater number of student's intake particularly more than 15000 are highly inquisitive for implementing blockchain technology. It is also observed that Universities with 1000-5000 students' intake have shown interest in blockchain technology. These universities might the ones that are technologically oriented universities.

From the Chi-square test table 4.35, it is observed that the significant value of Pearson's Chi-square test is 0.000< 0.05. So, the null hypothesis is rejected, and alternate hypothesis (H7) is accepted. Hence, it is interpreted that Strength of the students in the University and decision to adopt blockchain is dependent on each other.

Hypothesis H8: No of teaching and non-teaching staff of the University and decision to adopt blockchain is not independent of each other.

Table 4.36 Case processing summary for H8

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Total number of Teaching and Non-teaching members * If no, does your university have any plans to go for using Blockchain?	365	100.0%	0	0.0%	365	100.0%

Table 4.37 Crosstabulation for H8

Total number of Teaching and Non-teaching members * If no, does your university have any plans to go for using Blockchain? Crosstabulation				
Count				
		If no, does your university have any plans to go for using Blockchain?		Total
		Yes	No	
Total number of Teaching and Non-teaching members	Less than 200	3	7	10
	200-400	100	46	146
	400-600	183	22	205
	More than 800	3	1	4
Total		289	76	365

Table 4.38 Chi-Square tests for H8

Chi-Square tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.482[a]	3	.000
Likelihood Ratio	35.043	3	.000
Linear-by-Linear Association	28.527	1	.000
N of Valid Cases	365		
a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is .83.			

Interpretation: From the cross-tabulation table 4.37, it is observed that the Universities that have teaching and non-teaching staff ranging between 200 and 600 are more likely to implement blockchain. Whereas Universities with staff strength more than 800 and less than 200 are less willing to implement blockchain.

From the Chi-square test table 4.38, it is observed that the significant value of Pearson's Chi-square test is 0.000< 0.05. So, the null hypothesis is rejected, and alternate hypothesis (H8) is accepted. Hence, it is interpreted that no of teaching and non-teaching staff of the University and decision to adopt blockchain is dependent on each other.

Hypothesis H9: Years of experience of staff and decision to adopt blockchain is not independent of each other.

Table 4.39 Case processing summary for H9

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Your total years of experience * If no, does your university have any plans to go for using Blockchain?	365	100.0%	0	0.0%	365	100.0%

Table 4.40 Crosstabulation for H9

Your total years of experience * If no, does your university have any plans to go for using Blockchain? Crosstabulation

Count

		If no, does your university have any plans to go for using Blockchain?		Total
		Yes	No	
Your total years of experience	Upto 5 years	2	1	3
	5-10 years	4	0	4
	10-15 years	10	4	14
	15-20 years	114	33	147
	More than 20 years	159	38	197
Total		289	76	365

Table 4.41 Chi-Square tests for H9

Chi-Square tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.363[a]	4	.669
Likelihood Ratio	3.110	4	.540
Linear-by-Linear Association	.431	1	.512
N of Valid Cases	365		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .62.			

Interpretation: From the cross-tabulation table 4.40, it is observed that the Universities that have more experienced teaching and non-teaching staff are keener to implement blockchain.

From the Chi-square test table 4.41, it is observed that the significant value of Pearson's Chi-square test is 0.669 >0.05. So, the null hypothesis is accepted, and alternate hypothesis (H9) is rejected. Hence, it is interpreted that Years of experience of staff and decision to adopt blockchain is independent of each other.

4.13 Summary of hypothesis

Table 4.42 shows the results of hypotheses tests of the study

Table 4.42 Summary of hypothesis

	Hypothesis	Results
H1	There is a positive correlation between UTAUT and Use behavior	Accepted
H2	There is a positive correlation between TAM and use behavior.	Accepted
H3	There is a significant relationship between TAM and use behavior	Accepted
H4	There is a significant relationship between UTAUT and use behavior	Rejected
H5	Age of the University and decision to adopt blockchain is not independent of each other.	Rejected
H6	No of programs/courses offered by the University and decision to adopt blockchain is not independent of each other.	Accepted
H7	Strength of the students in the University and decision to adopt blockchain is not independent of each other.	Accepted
H8	No of teaching and non-teaching staff of the University and decision to adopt blockchain is not independent of each other.	Accepted
H9	Years of experience of staff and decision to adopt blockchain is not independent of each other.	Rejected

4.14 Chapter conclusion

This chapter gives detail description of data analysis and its interpretation. Different statistical test used in the study is explained with its interpretation. The demographic variables interpretation is performed first, and then the correlations of TAM and UTAUT variables with the use behavior factor is analyzed and interpreted. The hypothesis testing is done based on the research objectives using Chi Square test, regression analysis and Correlation. This signifies relationship between TAM, UTAUT and use behavior of blockchain.

Chapter 5

Findings, Conclusions and Future Scope

5.1 Introduction

This chapter is divided into nine sections; Section 5.2 summarizes the findings of data analysis and interpretation that gives the relationships between the factors and the outcomes. It also summarizes the hypothesis test results and its outcomes. Section 5.3 enlightens about the existing problems of managing university information system and the ideal solution for it using the blockchain technology. Section 5.4 gives the absolute method of implementing the blockchain in university information system. The basic guidelines and stepwise method of implementation of blockchain in university information system is also proposed. Section 5.5 covers various applications and processes that are developed till now using blockchain for education purpose. Section 5.6 gives the conclusion of this research study. Section 5.7 covers the general contributions of the research. Section 5.8 summarizes the limitations of this study and section 5.9 gives the future scope of the research study.

5.2 Findings of statistical analysis

5.2.1 Findings of correlation analysis

There is a weak positive correlation between the TAM variables and the UTAUT variables, according to the data analysis. This is said to be a favorable condition since else there would have been multicollinearity between the individual variables. It is observed that there is also a weak negative correlation between performance expectancy and social influence, as well as performance expectancy and the UTAUT Model's facilitating conditions. There is also a considerable positive correlation between UTAUT factors and TAM variables and use behavior.

5.2.2 Findings of multiple regression analysis

The TAM, UTAUT, and blockchain use behavior are all normally distributed, as per the Shapiro-Wilk significant value. It can be seen from the residual statistics data that the value is somewhere in the middle of the permissible range. This proves that the residuals are normally distributed. In general, there is a significant impact of TAM on use behavior for blockchain. It is found that the UTAUT does not have a significant impact on the use behavior of blockchain

5.2.3 Findings of Chi square test

To see if there was any correlation between the categorical variables, the Chi-square test was used. It has been noted that universities that have lately been established are hesitant to utilize blockchain technology. Universities that are old enough, i.e., more than 15 years old, are eager to incorporate blockchain technology into their systems. It is believed that the age of the university and the decision to embrace blockchain are mutually exclusive. Universities with fewer than or equal to 15-20 courses or programs are particularly interested in integrating blockchain technology. Blockchain has not piqued the interest of universities with more than 20 courses/programs. As a result, the university's number of programs/courses and its decision to embrace block chain are related.

It has been found that universities with a large student population, particularly those with more than 15000 students, are very interested in deploying block chain technology. Blockchain technology has also piqued the interest of universities with student populations ranging from 1000 to 5000. These universities are likely to be technologically oriented. The strength of the university's students and the decision to adopt blockchain are related. It has been observed that universities with a teaching and non-teaching staff of 200 to 600 people are more likely to use blockchain. Universities with more than 800 employees and less than 200 are less likely to deploy blockchain.

Pearson's Chi-square test is found to have a significant value of $0.000<0.05$. Hence, it is observed that number of teaching and non-teaching staff of the University and decision to adopt blockchain is dependent on each other. The universities that have more experienced teaching and non-teaching staff are more willing to implement blockchain. It is found that the years of experience of staff and decision to adopt blockchain is independent of each other.

5.3 Findings on existing problems in the current way of university information system and its solution using blockchain

The existing university information system has challenges with recordkeeping, badges, on-the-job training, and continuous professional training. The use of blockchain technology in the university information system provides a solution to the aforementioned issues. The blockchain is not editable. With the help of technology, students are discovering new and more convenient methods to do so. Learners are discovering that smaller bits of information acquired over time are far superior to a traditional credential-based diploma obtained from educational institutions.

Following are the wider scope of implementing blockchian in education:

- For recordkeeping, blockchain technology provides a secure store of time-stamped information, which can be extremely beneficial to all stakeholders.
- Badges (digital representation of any assessment) would be recorded, and time stamped using blockchain. Badges might then be utilized for up skilling and as a form of learning currency for advancement.
- Badges can be used to maintain track of all qualifications obtained throughout the course of a person's life. Such credentials would be more useful than the certificates that are currently issued.
- Blockchain technology could aid on-the-job training by centralizing massive data and validating the process and certification for such trainees.
- For continuous professional education, blockchain technology is utilized to record fragmented data from many sources, such as continuous learning, and stack it in a repository.

The blockchain mechanism ensures that everyone is held to the highest level of accountability. As a result, the problem of manipulation is resolved. The decentralized network ensures resilience, reliability, and longevity. The data entered blockchain-based systems is unchangeable. As a result, all transactions can be easily scrutinized and audited.

5.4 Absolute method of blockchain implementation in managing university information system

In the present student management system substantive data symmetry exists among colleges and utilizing organizations. The characteristics of blockchain, such as transparency and immutability, as well as their applications are discussed. The student data can be stored in the hyperledger framework's blockchain network, which incorporates the roles of students and universities.

Every university contains sensitive information that must be safeguarded. The current system, which is centralized storage, requires backups of the data kept in the central server. If the data (which could be a file or a folder) is modified on the server, the revised file will be accessed by everyone, which must be avoided. Universities can use blockchain to store data in each system connected to the network. A file cannot be easily updated with this kind of data storage. If a file is edited in one system, it cannot be modified in all other systems in the network since each system has its own copy of the database, which is known as a decentralized and distributed ledger.

Fig 5.1 shows the entities involved in blockchain network with context to education sector.

Blockchain in education, as seen in the above architecture, includes all transactions with Accreditors, Group projects, collaborators, online resources, teachers, and so on (Palanivel Kuppuswamy, 2019). Every entity in the block chain network acts as a node, performing transactions by arranging blocks into chains. The Hyperledger fabric blockchain can be understood as a state-machine replication paradigm, in which an administration maintains some state and consumers create tasks that change the state and produce yields.

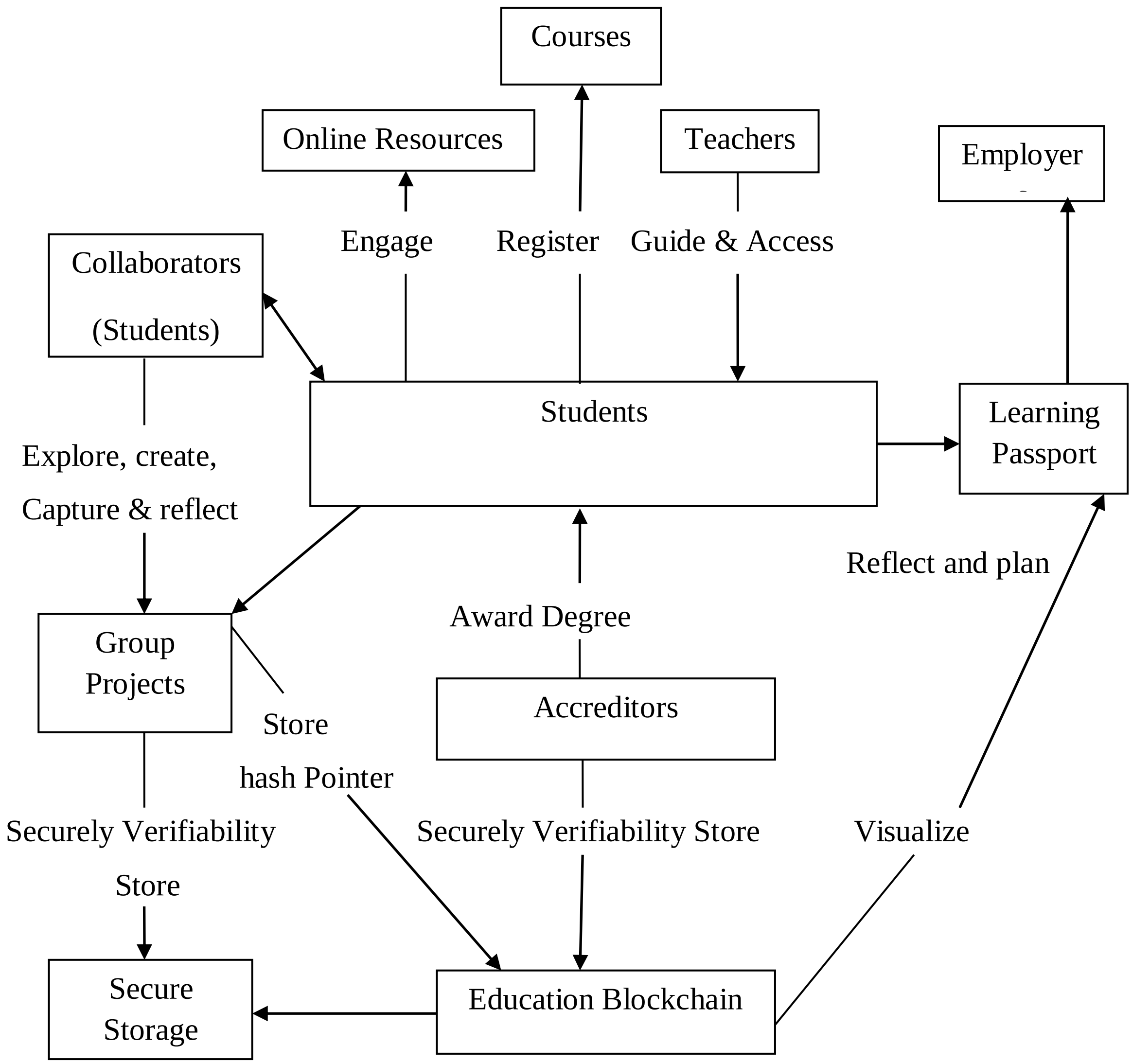


Fig: 5.1 Entities in bockchain (education) network (Palanivel Kuppuswamy, 2019)

.The blockchain copies a "trusted" registering administration through an appropriated convention, which is kept running by hubs associated over the Internet. These hubs share the shared objective of running the administration, but don't really confide in one another. SHA256 and RSA are the algorithms that are used to develop the blockchain platform.

5.4.1 Sample flowchart of student credentials verification

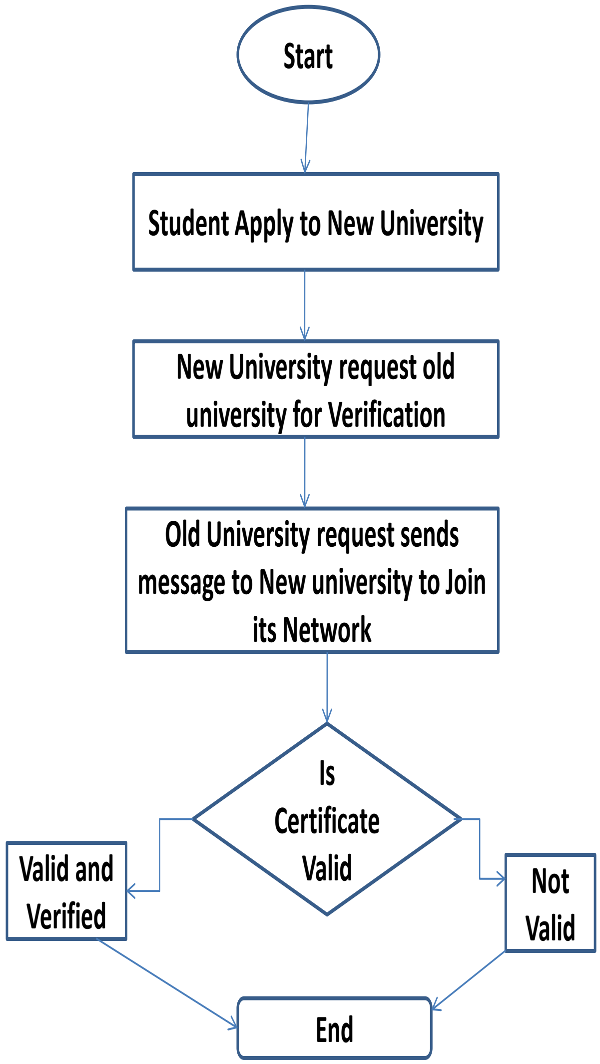


Fig: 5.2 Sample flowchart of student credential verification in blockchain platform (S.M.K.V. Pramod Kumar, K. Kiran Kumar, 2019)

Fig 5.2 shows the flowchart of how the credentials of students are verified through blockchain in between two specific universities. First student applies for a new university of higher education. The new university reviews the application and contacts the old university. To verify the certificates, the old university sends a request to join the blockchain network of the university. The new university then joins the network of the old university. Then the old university verifies the records in their database, and it validates the certificates.

5.4.2 Structure of sequence diagram for block storage in blockchain

Each student record is stored in the blockchain as a block. A block header and student data make up the block (S.M.K.V. Pramod Kumar, K. Kiran Kumar, 2019). The preceding block's hash code, current hash value, time stamp, and nonce are all included in the block header. The genesis block is the first block and contains no data. The data owner must create a request and submit student records to the blockchain network.

The data is received by the web interface and sent to the web server. When the web server receives the data entry request, it generates a hash code for it. Because each student record is treated as a block, a new block is formed. The block address is created after the block is created. The block is dispatched to be stored on the network.

The data owner receives an acknowledgement once the block has been correctly stored. The certificate can then be validated at any point in the future. The file code, file type, file upload time stamp, file name, data owner id (the id of the owner who uploaded the file), previous hash code, current hash code, block id, and nonce are all displayed in this distributed database's simple format. This is one of the demonstrations that can be used as a model for using blockchain technology. It will assist the universities in moving forward with the deployment of blockcahin for UIS management.

There are various other ways to go for implementation of blockchain wherein all the internal data of university could be stored and retrieved anytime and from anywhere. The inter-departmental communication could also be fulfilled using this immutable distributed database called as blockchain

Fig. 5.3 shows the storage of the block in blockchain.

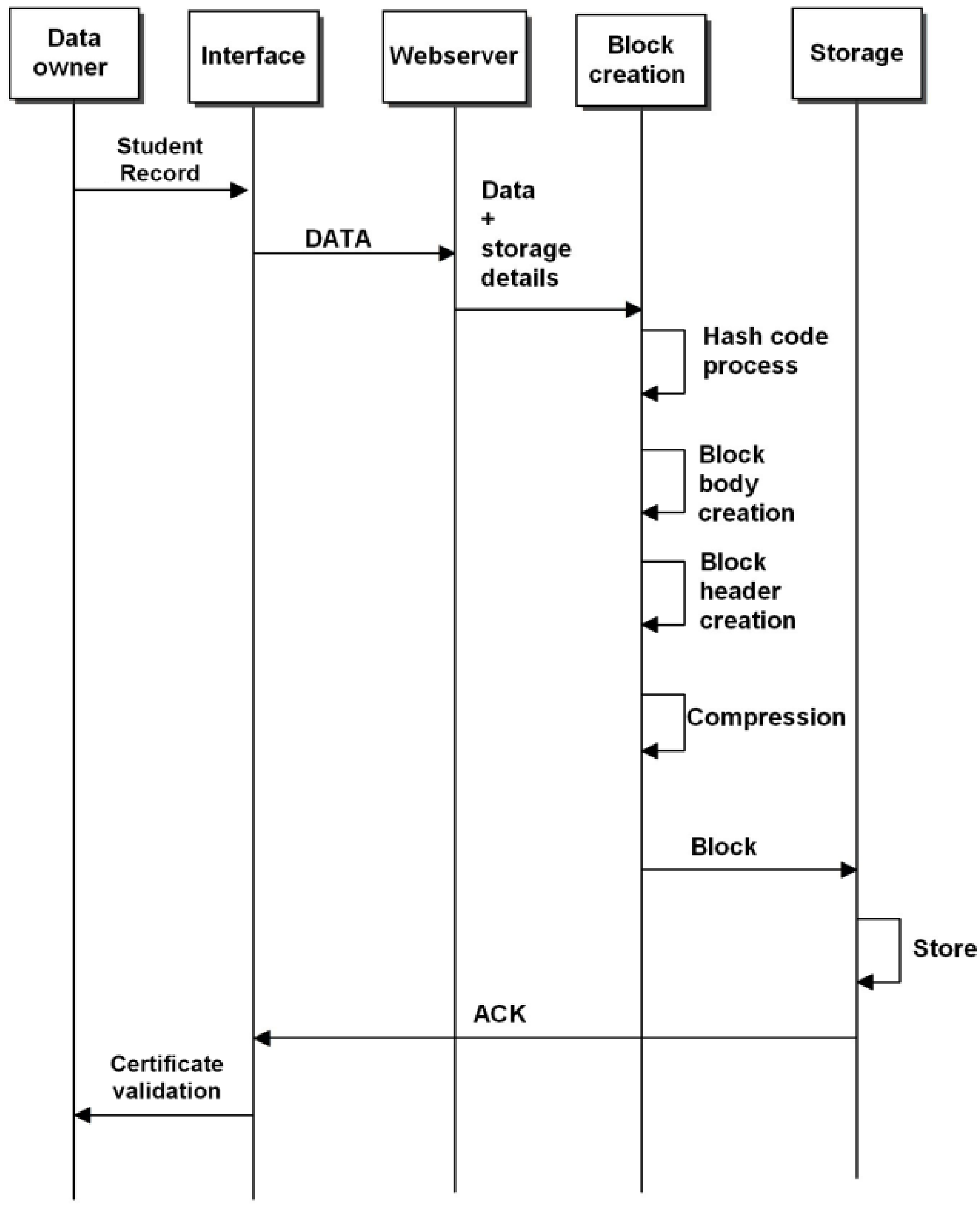


Fig: 5.3 Structure of sequence diagram for block storage in blockchain
(S.M.K.V. Pramod Kumar, K. Kiran Kumar, 2019)

The Blockchain mechanism which is powerful enough to completely alter the way we look at our current education system can be implemented in different ways which are as follows:

1. Digital certificates using blockchain technology

Immutable digital certificates that can be stored as public records can be created using blockchain technology. These records can be endorsed and certified at any time without risk of tampering by outside parties. As demonstrated in fig 5.4, the digital certificates are verified using the blockchain mechanism.

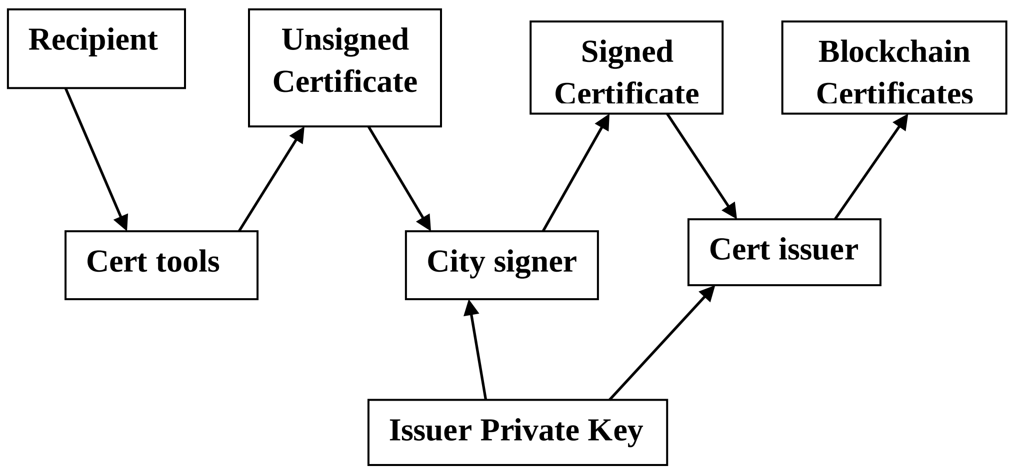


Fig: 5.4 Digital certificate verification process

Fig 5.4 shows the components a certificate issuer uses to:

- Make a list of recipients and create digital certificates for each.
- Cryptographically sign the certificates
- Issue the certificates on the blockchain

Traditional soft copies have a number of advantages over blockchain-based digital certificates. The benefits are as follows:

- Blockchain-based digital certificates are unchangeable and unforgeable.
- Certificates can only be read by people having blockchain access because the records are kept on a distributed ledger.
- Because the records are kept in a shared distributed ledger, the certificate can be validated even if the university that issued it no longer exists.

- The ledger's digital certificates can only be destroyed if all copies on all systems are also destroyed.

2. Blockhain replaces paper

The preservation of paper-based school certificates, degrees, diplomas, and other course credentials of each year's graduating students has always been a major concern for educational institutions all over the world.

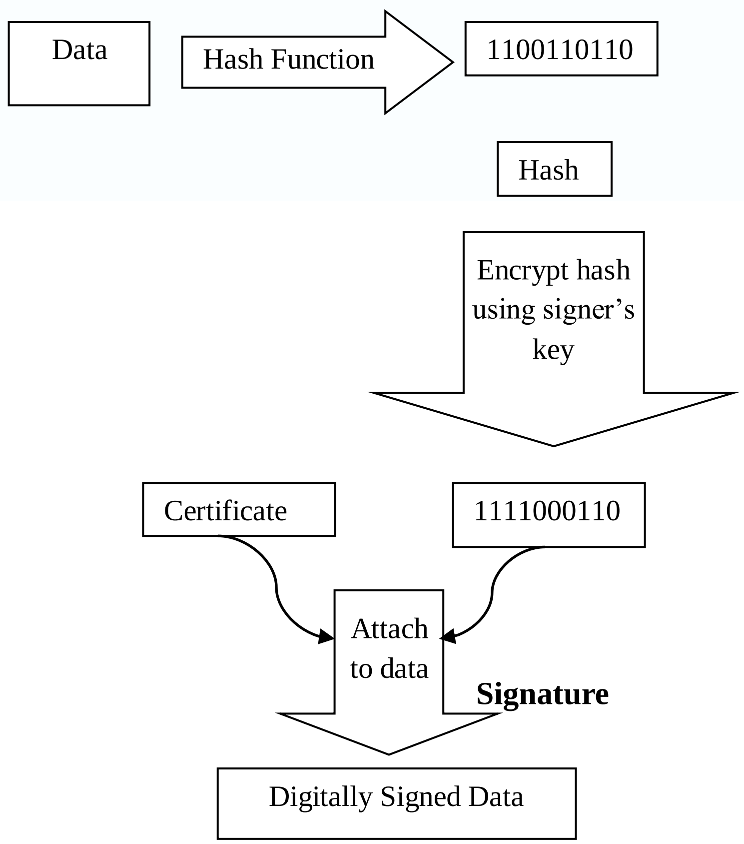
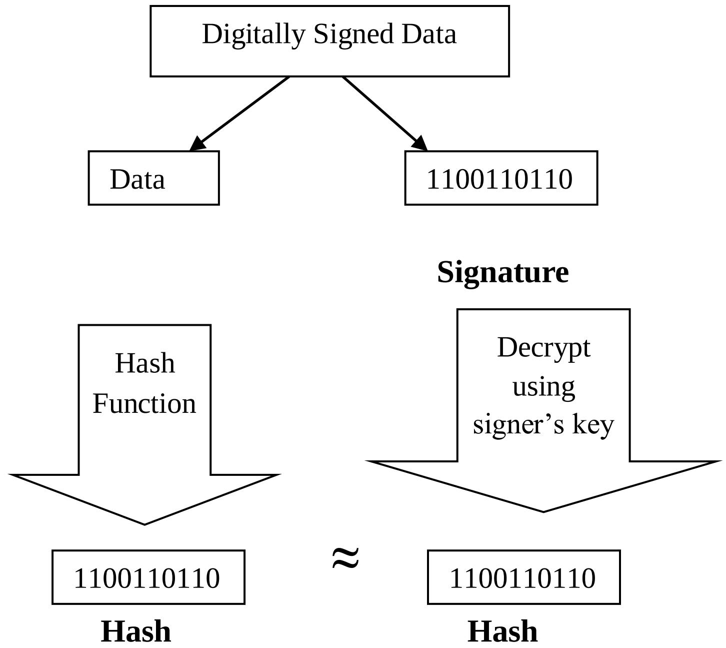


Fig: 5.5 Signing process



If hashes are equal, then Signature is Valid

Fig: 5.6 Verification process

Source: **https://www.jumpstartblockchain.com/article/digital-signature-in-blockchain**

The potential of secret documents being misplaced over time is always present. Blockchain may be the final solution for properly keeping these enormous records in a distributed ledger. Once recorded on the blockchain, information regarding a student's grades and courses will not be lost or tampered with. It's also nearly impossible to falsify or alter the data. The fig 5.5 show how the data is encrypted and verified using block chain mechanism and fig.5.6 shows the verification of signed data process. It shows how each piece of data is encrypted using a hash function and the signer's key before being turned into digitally signed data. The hashes of decrypted signature and hash data are checked during the verification procedure. The signature is said to be valid if the hashes are discovered to be equal.

3. **Making credentials more credible**

The usage of blockchain in education can help to increase the trustworthiness of credentials and academic papers. To do so, a blockchain wallet can be established that can assign digital certificates that students can access via their smartphones rather than the traditional paper certificates. These blockchain-enabled digital certificates are so secure that they could never be modified without all chain members agreeing for it. With the help of this revolutionary digital certification approach, employers may quickly verify the legality of a graduate's degree by clicking on a link or submitting the student's file. This digital certificate also grants students complete ownership of their documents, allowing them to securely share them with whoever they choose.

4. **Keeping records safe and easily accessible in the cloud**

Students have misplaced or lost their certification on several occasions, often when it was most needed. There are students from war-torn locations seeking academic opportunities in other countries, as well as students from a school whose server goes down or whose data is completely erased for some reason. In such cases, blockchain in education may be of use. Students can benefit greatly from blockchain-encrypted credentials.

5. **Financing education and blockchain**

While cryptocurrencies have been the most popular use of blockchain technology since its inception, the technology's potential is being explored across a wide range of businesses. Academic institutions require financial accounting, and blockchain might be used in an unprecedented way in education. Blockchain technology can be utilized to manage student scholarships and teacher salaries, resulting in a transparent and equitable funding structure for grants and initiatives.

5.5 Recommendations of various blockchain applications in education sector

The education sector can benefit from blockchain's scalability and use it efficiently in university information systems because it can be employed in private, public, and consortium sectors depending on the usage and scope of the blockchain. The development of blockchain-based applications can be separated into three stages, according to (Sura I.Mohammed Ali, 2021): Blockchain 1.0, 2.0, and 3.0. Blockchain 1.0 was created to make simple monetary transactions more convenient, and it was used to create cryptocurrencies. Then came the introduction of Blockchain 2.0 for properties and smart contracts. These smart contracts set certain rules and criteria that must be obeyed before they can be registered on the blockchain.

Without the intervention of a third party, the registration process is completed. Blockchain 3.0 has a wide range of applications in a variety of areas, including government, education, health, and science. The use of blockchain in education is still in its early stages. A few numbers of educational institutions are using blockchain technology. The bulk of these organizations use it to confirm and disseminate their students' academic credentials and/or learning outcomes. Blockchain technology, on the other hand, according to industry experts, has a lot more to offer and has the potential to revolutionize the area. In Table 5.1, a list of all the blockchain apps available in each category is mentioned (Grech, Alexander; Camilleri, Anthony F, 2017).

Table 5.1 Blockchain applications in education

Sr. No	Application Category	Name of Application	Features
1	Certificates Management	Blockcerts	a. Handles various types of academic credentials, transcripts, student certificates, and other achievements records. b. It also verifies official transcripts or certificates and issues them.
2	Competencies & learning outcomes management	ODEM	a. This learning application can be termed self-descriptive because it has all information for a variety of activities and can measure and evaluate students' performance using both qualitative and quantitative parameters. b. For students, this learning environment gives immediate/direct support as well as meaningful feedback.

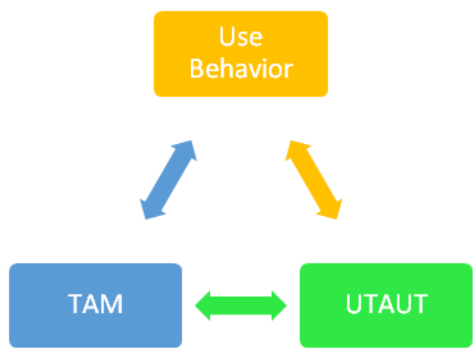
3	Securing a collaborative learning environment	Ubiquitous learning (U-learning) system	a. Use of blockchain to support the learning environment and provide students with a secure collaborative learning environment that can be accessed at any time and from anywhere. b. To enhance effective communication between teachers and students, U-learning offers an interactive multimedia system.
4	Fees and credits transfer	EduCTX system	a. The transfer of credits or fees is handled and approved by a third party/intermediary for educational institutions. Because of its high security level, the blockchain may be utilized as an efficient way to transmit information and eliminate the need for third or intermediary parties. b. Tokens are used to facilitate the transfer process in the EduCTX system. For learning units like as certificates, courses, and diplomas, these tokens can take any digital form. To handle the secure transfer process, each educational institution can have its own EduCTX address.
5	Obtaining digital guardianship consent.	Sony Global Education	a. The decentralized structure of blockchain helps to speed up the consent collection process without jeopardizing its privacy. This has a significant impact on many students, parents, and educational institutions' collection and commutation processes. b. A system that allows public schools to grant permission privileges to any third-party institution that wants to meet with their students without having to acquire parental agreement each time.
6	Competition management	e-commerce operation sandbox	a. It's a system for determining a student's professional knowledge

			and expertise. b. This system is being created in order to create an evaluation system that measures and monitors students' operational abilities.
7	Evaluating students' professional ability	APII	a. It is an application that connects educational institutions and employers to provide all relevant information about recruitment and industry criteria. b. It is used to assess students' professional abilities based on their academic achievements and performances, and the results can then be shared with any industry that is interested. Based on the blockchain's clustering algorithm, this evaluation system was created to measure and analyze student's abilities
8	Copyrights management	CHiLO	It's a decentralized learning system for e-book copyright and ownership protection.
9	Enhancing students' interactions in the e-learning	Disciplina	a. This application was designed to improve learning engagement. b. Based on specified regulations deployed on the blockchain network, it awards top-ranked learners in the form of virtual currency
10	Examination review	dAppER	a. When disrupting exam papers among external examiners, this technique was established considering quality assurance criteria. b. It is helpful in managing the quality assurance systems
11	Supporting lifelong learning	BitDegree	This allows learners to create an effective strategy for their educational journey based on their desired career path by giving them complete control and ownership over their learning processes

5.6 Conclusions

From the primary data analysis and the secondary data analysis, the following findings are derived.

1. TAM which is defined by components (attitude, perceived usefulness, perceived ease of use and intension to use) and UTAUT which is defined by (performance expectancy, effort expectancy, social influence and facilitating conditions) are interrelated variables which has a great effect (correlation) on the use behavior of respondents for adoption/implementation decision of blockchain technology for student management in universities. Not only for universities, TAM and UTAUT can be used in any context of technology implementation and adoption.
2. TAM has a significant effect on the use behavior whereas the UTAUT do not have a significant impact on the use behavior of respondents for block chain.
3. A model of interdependence is derived.



4. The researcher has identified several demographic factors to see how the respondents belonging to different categories of demography respond to the decision of implementing blockchain in their respective universities.
5. The demographic factors include age of the university, number of programs offered by the university, strength of the students, number of teaching and non-teaching staff, experience of the teaching and non-teaching staff. It is interpreted by the chi-square tests that out of all these demographic factors, age of the university and experience of the staff do not contribute significantly to the decision of adoption of blockchain technology.

6. From the secondary data, it is observed that many universities have not opted blockchain due to following reasons:
    a. For successful implementation of blockchain, universities must have necessary collaborations with other universities and stakeholders covering larger region. It is observed that this necessity is lacking in our Indian universities.
    b. It is also observed that, besides the way universities operate, the employees also need to shift paradigms. Currently, IT is designed to exclude others. This design needs to shift to include others, making them participants instead of subordinates, clients, or users. This requires a vastly different way of thinking. This situation also needs to be improvised.
    c. The size of the university is also affecting the integration of blockchain in managing student information system. When any university has high complexity in its structure, IT systems, and decision making, it is harder for them to integrate blockchain into their business processes because of the required collaboration and coordination.
    d. Universities are hesitant to invest in blockchain. Universities might not think the technology has proven itself yet, are risk-averse, have recently invested in new digital infrastructure, or have existing legacy systems delaying the introduction of new technology.
    e. Lack of blockchain curricula is also one of the reasons why universities have not yet opted for blockchain.
    f. It is also observed that many universities do not know what their future market function will be. Because of this, they do not know which use cases will be viable in the long-term. This creates a solution-before problem thinking environment. Solution-before-problem thinking means that universities will try to integrate a blockchain in business processes where it offers little to no practical benefit.

5.7 Contribution of study

This research study contributes to identifying the factors that are responsible in adoption of blockchain in education sector specifically in relation to university information system. The conceptual model using TAM and UTAUT variables is the core theoretical contribution. This conceptual model has been designed using the variables of two adoption theory models, namely TAM and UTAUT. The proposed blended interdependence model of TAM and UTAUT consists of those factors that influence the use behavior of universities to use the blockchain in university information system.

From this study, it is observed that current university management needs to analyze these factors that could be useful for taking a decision to adopt blockchain in managing the student database in universities. It has also been noted that many universities are unaware about the knowledge and infrastructure required for use of blockchain. This study also presents an opportunity to universities to benefit from the guidelines on how to implement blockchain in managing the university information system and also how it can be implemented in improving teaching-learning process and Inter-departmental data sharing and management. Conclusively, the universities will have a clear understanding of all the features that are responsible for use of blockchain in university information system. The guidelines on how to use the blockchain in UIS will also be helpful in taking a decision on the adoption of blockchain in managing the student information system.

5.8 Limitations of research

- Due to limited constructs/variables of TAM and UTAUT basic model, more factors were not analyzed over studying the use behavior of universities for implementing blockchain in university information system

- Due to COVID-19 pandemic situation the one-to one interview method and interaction was not possible. Due to which inaccurate judgement on response of university authorities was weak and limited.

- While the study incorporates different factors into the decision-making model, there are numerous model modifications and components to consider in order having a deeper understanding of the dynamics of university decision-making.
- Blockchain research has hardly touched the surface so far. There are still a slew of concerns and factors to be thoroughly investigated, spanning from technological to social implications. For both scholars and practitioners, blockchain represents a true paradigm change. Most importantly, it is fundamental to the transformative promise of the global community as a whole.
- Quality, content, cohesion, and direction are still lacking in blockchain-related research.
- Because the data set employed in this work was limited to 365 respondents, there is a shortage of commonly available data to complete the requisite robustness tests, which future research incorporating larger data collections could address.
- The respondents were mostly university officials and employees working with information system maintenance, which were able to provide insight only from a user perspective. They do not represent the totality of blockchain stakeholders such as developers and industry professionals.

5.9 Future scope of research

- As only TAM and UTAUT model was considered, the future scope may include use of other theories of adoption mentioned in the literature review to cover larger scope of dependent factors.
- This study could cover few blockchain applications that could be implemented in university information system.
- Future scope may cover more in number with latest available modifications.
- Future scope may also include the identification of various cluster based on blockchain adoption stage

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Questionnaire

Title: Study of factors influencing the use of Blockchain technology in Student Information System at Universities

Part A: General Information

Name:

Designation

Name of University

Type of University:

- Central
- State
- Private
- Deemed

University is located in which region?

- Eastern India
- Western India
- Northern India
- Southern India

How old is the University?

- Upto 5 years
- 5 years to 10 years
- 10 years to 15 years
- 15 years to 20 years
- Older than 20 years

Number of Programs/Courses offered

- Less than 10
- 10 to 20
- 20 to 30
- 30 to 40
- More than 40

Approximate Strength of Students in the University

- Less than 5000
- 5000 to 10000
- 10000 to 15000
- 15000 to 20000
- More than 20000

Total number of Teaching and Non-teaching members

- Less than 200
- 200 to 400
- 400 to 600
- 600 to 800
- More than 800

Your total years of experience

- Up to 5 years
- 5 years to 10 years
- 10 years to 15 years
- 15 years to 20 years
- More than 20 years

Your Age

- Up to 30 years
- 30 years to 40 years
- 40 years to 50 years
- 50 years to 60 years
- 60 years and above

Your Management Level

- Lower
- Middle
- Top

University's interaction with external agents (UGC, State Govt Welfare, Banks, etc), if any

- Less than 2
- 2 to 4
- 4 to 6
- 6 to 8
- More than 8

Are you using any software for managing your business process?

- Yes
- No

If yes, is it custom built or standard application?

- Custom built
- Standard Application

Name of the Application used for managing your business process?

____

How do you manage your software database?

- Within university (on-premise)
- Over cloud

Have you heard about Blockchain technology?

- Yes
- No

Is your software Blockchain enabled?

- Yes
- No

If yes, since how long have you been using Blockchain enabled application?

- Less than 1 year
- 1 year to 2 years
- 2 years to 4 years
- 4 years to 6 years
- More than 6 years

If no, does your University have any plans to go for using Blockchain?

- Yes
- No

What do you think could be the reason for not adopting Blockchain?

- Technology readiness
- Lack of IT trained staff
- Technology too new to implement
- Technology is expensive
- Others

Part 2: Blockchain Technology adoption factors

There are 34 identified factors that influence the use of blockchain technology for managing the student information system at. The factors are rated on 5 point likertscale. Where rating 1 means that you strongly disagree and rating 5 means that you strongly agree with the statement. Your sincere response can help in evaluating these factors empirically.

Sr. No	Question	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1	Blockchain enabled immutable and distributed data can be a valuable means for managing a student database in a University's information system.	□	□	□	□	□
2	Users connected through a Blockchain enabled information system can view transactions and data related to their system, which gives every user an opportunity to enhance performance in all sense	□	□	□	□	□
3	Blockchain enabled information systems are based on recent technological standards and it fulfills the need of students, employees, statutory bodies and other stakeholders of University information systems.	□	□	□	□	□
4	Management support and a positive attitude is important for successful adoption of Blockchain enabled information systems	□	□	□	□	□
5	The University information System should be able to withstand error that occurs during data transactions	□	□	□	□	□

6	For a better University information System, data access & transaction execution time should be faster	□	□	□	□	□
7	While executing multiple data handling, the access and tracking of student's data in University information system should occur accurately without any change.	□	□	□	□	□
8	The data transaction histories should be transparent, so that malicious or unintentional changes can be curbed.	□	□	□	□	□
9	Universities that hope to attract students from across the globe need to bring their information system and processes in line with modern student expectation	□	□	□	□	□
10	The system should allow data sharing and transaction between different networks with different configurations successfully ensuring interoperability and Compatibility.	□	□	□	□	□
11	The University Information system should be scalable in order to handle multiple transactions without interrupt and error.	□	□	□	□	□
12	Any technology should have the ability to monitor data transaction from a single location or one point of communication.	□	□	□	□	□
13	Student enrollment at Universities is increasing every year. The capability of handling voluminous data of student in existing non distributed and non-mutable database is not as per the expectation.	□	□	□	□	□
14	The available displayed information of students in University Information	□	□	□	□	□

	System should be trusted by foreign entities.					
15	The information storage and management needs to be immutable, tracked and secured for long term purpose	□	□	□	□	□
16	Any new information system should securely allow access to personnel information with prior authorization and permission	□	□	□	□	□
17	The speed of data transaction within a network should be high, independent and unaffected irrespective of unavailability of memory or space	□	□	□	□	□
18	The use of distributed database technology ensures automatic execution of smart contract that increases the overall performance & efficiency of the system	□	□	□	□	□
19	The Universities prefer such a University information System which do not involve manual handling of process and require low maintenance	□	□	□	□	□
20	The structure of new technology must be feasible and should be able to work successfully in spite of all dependent and independent parameters	□	□	□	□	□
21	Many Stakeholders now prefer open source system in their organizations to have good accessibility of records which are declared public	□	□	□	□	□
22	It if found that the adoption and use of new digital innovation helps in	□	□	□	□	□

	advancement in way of managing and storing student data at universities					
23	The use of new technology must be supported by an efficient technical and organizational infrastructure	□	□	□	□	□
24	There should be some Regulatory Act for protection of valuable information and ownership at Institute level	□	□	□	□	□
25	The Information System should be flexible in the process of data management	□	□	□	□	□
26	The standardization of technology in education system globally allows different inter and Intra stakeholders of education systems to work cohesively in a unique way	□	□	□	□	□
27	Knowledge and capabilities of employees change organizations view to spot and notice the worth of adopting recent new technology models	□	□	□	□	□
28	It is found that there is less focus given on back office part of any new technology and more on user interface or user control	□	□	□	□	□
29	When an organization has high complexity in its structure, IT systems, and decision making, it is harder for them to integrate new technology into their processes because of the required collaboration and coordination	□	□	□	□	□
30	The use of standard technology ensures fulfillment of requirement of learners, employees, Gov and other stakeholders	□	□	□	□	□

31	University's current technical infrastructure and software systems lack the adequate data protection. It is hard to detect frauds in issuing and storing of transcripts of students	□	□	□	□	□
32	If the number of intermediaries involved in any data transaction is less and if the technology is self-automated in function, then data is well processed	□	□	□	□	□
33	The price volatility of new adopted technology of University information System is not significant in comparison to the performance of the system.	□	□	□	□	□
34	In University information System, the transactions and records must be consistent, accurate and durable once verified	□	□	□	□	□

****