Reduction of Perilous Pandemics by Employing Blockchain and Machine Learning Technology

Thesis

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COMPUTER SCIENCE & ENGINEERING

By

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Declaration by the Scholar

I hereby declare that the work presented in this thesis entitled "**Reduction of Perilous Pandemic by Employing Blockchain and Machine Learning Technology** " in fulfilment of the requirements for the award of Degree of Doctor of Philosophy, submitted in the Maharishi School of Engineering and Technology, Maharishi University of Information Technology, Lucknow is an authentic record of my own research work carried out under the supervision of **Prof. (Dr.) Manish Varshney,** I also declare that the work embodied in the present thesis-

i) is my original work and has not been copied from any journal/ thesis/ book; and

ii) has not been submitted by me for any other Degree or Diploma of any University/ Institution.

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Supervisor's Certificate

This is to certify that **Mr. MD. IQBAL** has completed the necessary academic turn and the swirl presented by him is a faithful record is a bonafide original work under my guidance and supervision. He has worked on the topic "**Reduction of Perilous Pandemic by Employing Blockchain and Machine Learning Technology**" under the School of Engineering and Technology, Maharishi University of Information Technology, Lucknow.

Date: 12 08 2022

Name of Supervisor

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ABSTRACT

In pandemic situations, especially in conditions where only solution to minimize the spread of virus is lockdown. It is evident that most of the sectors are affected locally or globally. The education sector is one of the most hit sector in such cases. The use of digitized means to impart knowledge certainly fulfil the gap, but a thorough assessment of the student isn't done statistically. We can't determine that the student is perceiving the knowledge in an online class or not. Our research focuses on this problem and an approach is presented based on Machine Learning which gives a statistical value of the student's perception of digitized learning. Our study used a quantitative research approach and a limited sample size of Indian learners from four categories of education in India: universities, technical institutes, colleges of higher education, and schools, which were all chosen based on the participant's state of residency. Data was gathered through a survey of 1439 students from an Indian institution in the Lucknow region. According to data analysis and study findings, the K-Nearest Neighbour and Random Forest Algorithms outperform other classifiers. The study's findings will benefit in the creation of learning apps that consider students' viewpoints on successful network technology.

Moreover, the authenticity of the medicines especially those which can control a pandemic poses a very important role. Since, the level of demand doesn't meet the level of supply in pandemics. To churn out some monetary benefits, the markets began to flood with counterfeit medicines related to the pandemic like COVID-19. It is quite impossible for a common man to differentiate between the fake and original ones. Our study is related to securing the authentic medicines and other important supplies like testing kit for COID-19. As we recently saw a sudden upsurge of the counterfeit testing kits. The way we are securing the COVID-19 testing kits or vaccines or any other important medical supply is related to the blockchain technology. The majority of the duplicity originates from the Supply Chain Management which needs to be secured via blockchain, because of its inherent properties.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Epidemics and pandemics have sunk civilizations throughout history and brought even the most powerful nations to its knees. A number of the worst pandemics have occurred, including Spanish flu, Swine flu, West African Ebola outbreak, and the Zika virus outbreak. The influenza season of 2017-18 was a very severe season, with a high frequency of outpatient clinic visits; it was also geographically widespread for a prolonged length of time. A small number of Machine Learning and Blockchain learning technologies have been implemented to cancel out the negative impacts of the worldwide pandemics. Despite the fact that global health objectives are being re-aligned to reflect the increased burden of non-communicable illness, the recurring danger provided by big infectious disease epidemics and pandemics continues to exist. In less than two decades since the beginning of the twenty-first century, the world has already experienced a number of severe epidemics or pandemics, three of which have been designated as PHEIC by the WHO. According to the PHEIC declaration, WHO would assist with the coordination of an emergency response with the afflicted country and several other nations across the globe. This is a humongous approach in transportation sector either concerning with the livestock or any other transportable material. Population expansion, globalisation, climate change, and the rise in antibiotic resistance are just a few of the variables that are increasing the likelihood of disease outbreaks across the world.

Preparedness for catastrophes and other emergencies are major variables influencing the frequency of large epidemics and pandemics, as well as the effectiveness of response. Political prowess, to be strong financially and a better public health are the major factors which is essential for getting prepared for pandemics.

National and international emergency response plans have been found to be inadequate during both the Ebola virus disease and Zika virus epidemics in Africa from 2013 to 2016, respectively. Developing strategies to deal with the most pressing problems facing officials based on historical data, present knowledge, and future projections is essential if we are to dramatically improve our ability to stop outbreaks of infectious

disease. Aside from outbreaks and illnesses, many of these concerns have broader implications for disaster preparedness and health system improvement.

Large outbreaks of disease frequently occur in countries that are deprived economically, frequently at the places where long-term civil disturbance has damaged or impeded the establishment of disease monitoring and preparedness. In addition to serving as breeding grounds for the introduction and spread of illness, these unsafe environments obstruct the effective response to outbreaks. Violence by warring groups hampered a coordinated response from the government and foreign aid agencies, which resulted in the world's most severe epidemic of cholera in Yemen in 2016, with more than a million cases. As a result, the first policy task is to guarantee that health is recognized as an individual right to own, as well as a comprehensive security must also be provided towards health. Politicians are often relied upon by the pharmaceutical and global health sectors, but the significance of choosing to fight for their interests cannot be overstated. Thus, the new World Health Organization Director General Tedros Adhanom Ghebreyesus' recent call for universal health coverage is a positive and major move.

The SARS-CoV-2 coronavirus is to blame for the COVID-19 pandemic, which started in Wuhan, China, in November of this year and has since spread around the globe. A dry cough, a cold, a fever, and other symptoms are all signs of this virus. There was a declaration of a pandemic on March 11, 2020, by the World Health Organization (WHO). More than 690 million people are already malnourished, and this figure is anticipated to climb by 132 million before the end of the year. As a consequence of the pandemic, an estimated 132 million individuals are at danger of descending into horrific poverty.

The following sectors will be affected by COVID-19 or any other pandemic:

- Transportation
- Tourism Industry
- Small and Medium Enterprises (SME’s)
- Educational Institutions
- E-commerce
- Healthcare Systems

The epidemic has placed a large number of lives in risk and has a shattered reputation. As suppliers lose their jobs, become ill, or pass away, the food security and sustenance of millions of women and men are jeopardised, with those in low-wage countries, particularly the most marginalised populations, such as small-scale ranchers and indigenous people groups, being the most severely affected. It is possible to cope with this via the use of testing kits; COVID-19 testing kits are being made and distributed in large quantities to battle the pandemic as rapidly as possible; nevertheless, it is very unlikely that the validity of the kits will be confirmed all around. Because of the epidemic, it is essential to work quickly while while maintaining high precision. Multiple validating parties may certify that these kits are in working order, and the entire thing can be summed up as SCM, which is what is specified in the scope of blockchain to deal with COVID-19. A number of bogus testing kits have been discovered in the past. The Food and Drug Administration has recently issued a warning about bogus COVID-19 goods. The Food and Drug Administration has been working with merchants to remove numerous misdirecting goods off shop shelves and from the internet. The agency will continue to monitor web-based media and online commercial canters for the promotion and sale of deceptive COVID-19 goods. As reported by the NDTV news channel [27], over 4 lakh counterfeit testing kits have been discovered in Noida. When a representative of another firm filed a complaint against the company, the company was exposed.

An investigation into a situation where a few personnel from Indonesia's state-claimed drug group Kimia Farma were apprehended for supposedly cleaning and swapping COVID-19 nasal swab test kits has come to light, according to another news outlet. At the Kualanamu International Airport in Medan (North Sumatra), police estimate that over 9,000 passengers were exposed to these kits, which were cleaned and re-used [28] [28]. The above-mentioned incidents serve as inspiration for our suggested framework, which is intended to prevent similar situations from occurring in the future. The structure that ensures that the supply chain network for the COVID-19 testing kit is transparent, secure, and legitimate is described here. By employing KYC or other identifying techniques, the system assures that no authorised person may review the authenticity of a transaction since only official or well-known validators can be added to the blockchain by using the system. In order to ensure data security, cryptographic functions are used. This is because the data will be kept on the network in an encrypted

state, and only relevant information will be seen to the appropriate relevant party. Only a system capable of providing these kinds of capabilities can do this, and blockchain technology will be an excellent option for this since it is a well-known or rising technology that is known for transparency and security. As previously stated, this technology has been used to create a large number of SCM portals.

1.2 BLOCKCHAIN

A blockchain is a public (decentralised) system that fulfils the twin purpose of recording and keeping the records of a transaction. Blockchains are becoming more popular. The data on this blockchain is stored on a network of personal computers known as 'nodes,' and there is no central authority over the data.

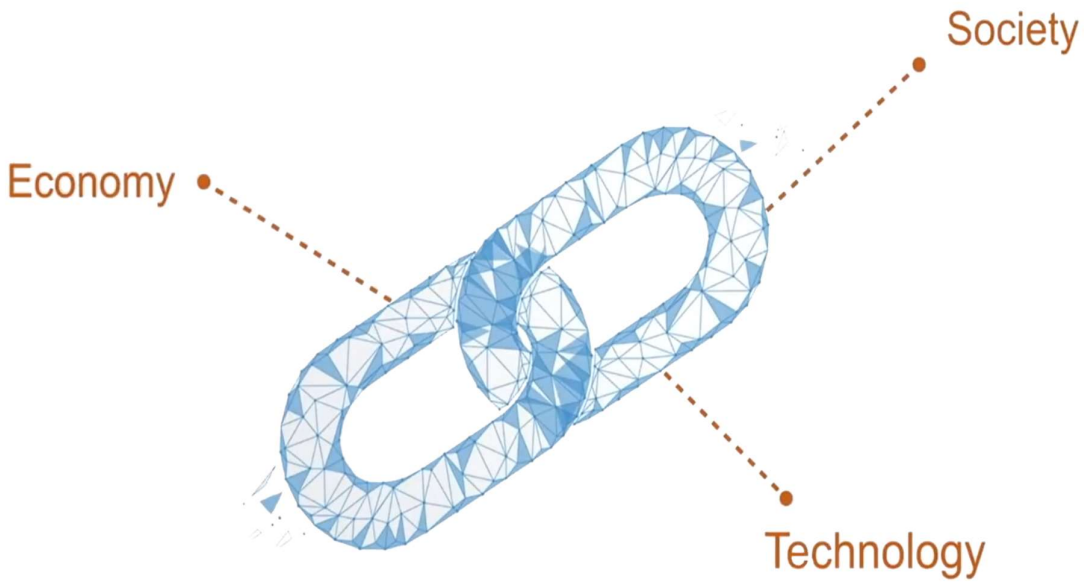

Figure 1.1: The use cases of the Blockchain in different domains.

Blockchain is described as an immutable ledger that is used to record information parts in a logically separated manner, according to the definition. It enables components to communicate without the need for a focal point or an outsider who is assumed to be there. In the blockchain, there is a constantly changing collection of information

passageways that are crammed together to create information blocks. These blocks are linked to the previous and future blocks of the blockchain via cryptographic limitless supply of the blockchain. Anyone may read and write information records/blocks in the first kind of blockchain, and these records/blocks can be recognisable, writable, and carefully created by anyone. For example, it allows for decentralised information and information sharing amongst executives. Because of these characteristics, blockchain is very intelligent when it comes to a variety of applications. Additionally, blockchain allows for the creation of smart contracts, which are contracts that may be activated without the need for a centralised authority.

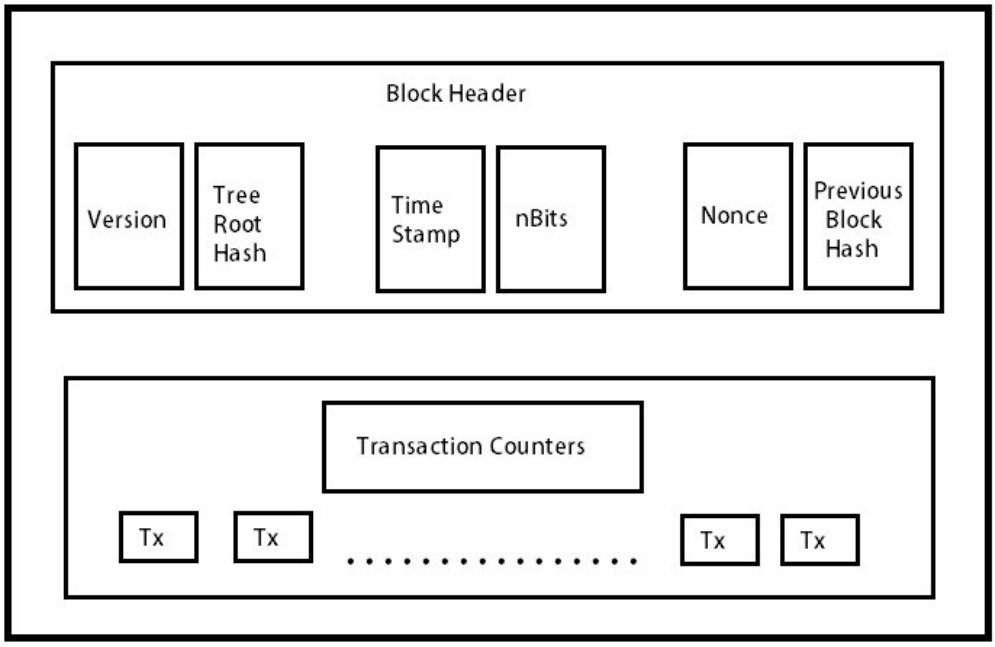

Figure 1.2: A typical block in a blockchain

Figure 1.2 depicts the construction of a single block in a distributed ledger technology (DLT). Each block is divided into two parts: a header and a body. There are many parts in the block header, including the following: Version, Timestamp (represents current time), nBits (the lowest threshold for a valid hash), Nonce (for each hash calculation, which normally starts with 0 and grows), and the hash of the parent block. In addition to

an exchange counter and a few exchanges, the block content contains other information. The maximum number of exchanges that a square may accommodate will be determined by the size of the block and the size of each individual exchange. When it comes to confirming trade confirmations, Blockchain makes use of an imbalanced arrangement of cryptography. An asymmetric cryptographic digital signature is used in an untrustworthy environment to protect sensitive information.

In typical cantered transactional structures, each exchange must be examined by the focal trustworthy substance, resulting in the central servers' cost and output choke spots as a consequence of the high number of exchanges. Third parties are no longer necessary to use consensus techniques in blockchain to ensure that information consistency is maintained across the distributed network. Trades may be allowed in a short period of time, and fair diggers would not accept exchanges that were invalid. Because of the way they are implemented on the blockchain, it is almost impossible to remove or reverse transactions. In each block, fraudulent transactions are identified as soon as they occur. The blockchain allows a user to communicate using a randomly created address, which does not reveal the user's actual identity to other parties. It is important to note that, owing to the inherent limitations of blockchain, it cannot provide comprehensive privacy protection.

Recent years have seen a considerable increase in interest in blockchain technology across a wide range of industries and sectors, including healthcare, since it provides a more secure and distributed data storage system that can run successfully without the need for a centralised administrator. For example, blockchain technology has the ability to revolutionise the healthcare sector in a multitude of ways, including simplifying data sharing across all providers, maintaining selected privacy, and securing data. As a possible platform for increasing healthcare data's authenticity and transparency, blockchain has also gained a lot of attention and interest, with uses ranging from securing rights in electronic health records (EHRs) to speeding up claims processing. The most striking characteristic of the blockchain ecosystem is that the network itself checks and validates subsequent transactions after digital validation and verification has occurred. As a result, assets may be traded between parties immediately.

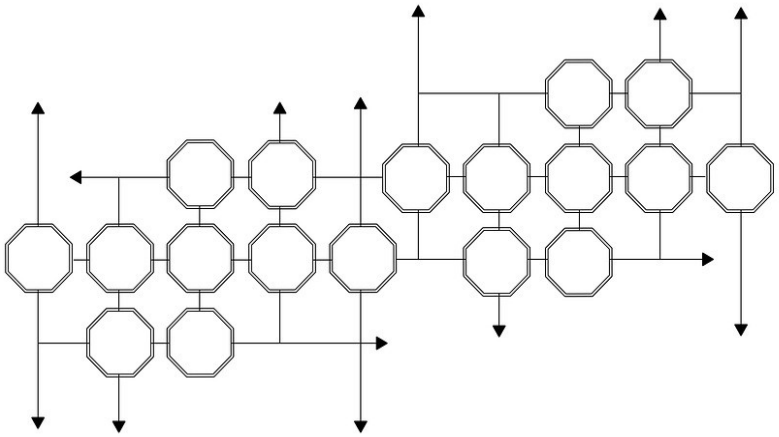

Figure 1.3: A depiction of ever growing chain of blocks.

1.3 MACHINE LEARNING

In the same way that people learn from their previous experiences and machines obey human directions, we can teach robots to learn from their prior data and perform the same things humans can do quicker. As a result, the term "machine learning" was coined. Aside from just learning, comprehension and reasoning are also important. For the sake of simplicity, let's use the following real-world scenario as an example:

Consider the case of someone who enjoys discovering new music and has a strong preference for or a strong distaste for certain genres. Because of this, the listener chooses this on the basis of the song's style, speed and genre. To forecast the next song in terms of a basic machine, it becomes more difficult as the data grows and the options get more complex; this is where the use of machine learning comes in. Prediction models are built using the data, and when a new data point is added, the model may forecast for it. The more data you have, the more accurate your model will be.

In computer science, machine learning (ML) is a subtype of artificial intelligence that enables computers to think and learn without being explicitly instructed. The Venn diagram in Figure 1.4 depicts how this hierarchy may be classified. To get better future results for a given issue, machine learning is utilised in a range of computing tasks. Its

basic purpose is to train the machine using data that has been supplied (the data might be labelled in the case of supervised learning or unlabelled). Computers should be able to learn from their past experiences.

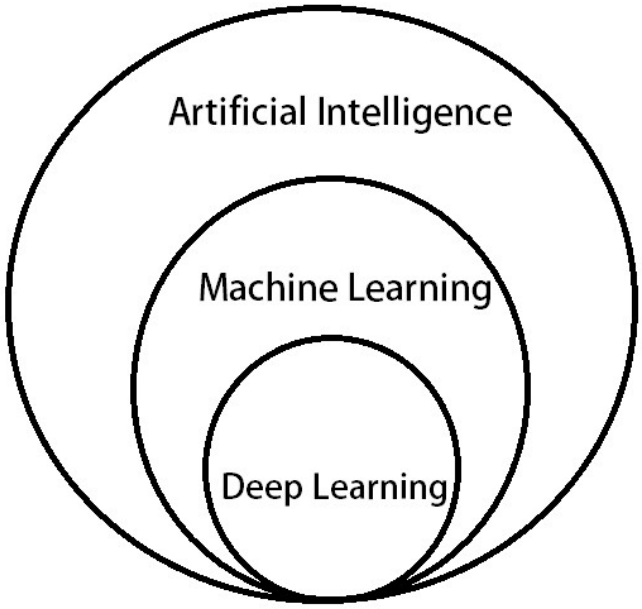

Figure 1.4: Representation of artificial intelligence, machine learning and deep learning

The computer may learn in a variety of methods, including supervised, unsupervised, and reinforcement learning. Fig. 1.5 shows a more comprehensive categorization.

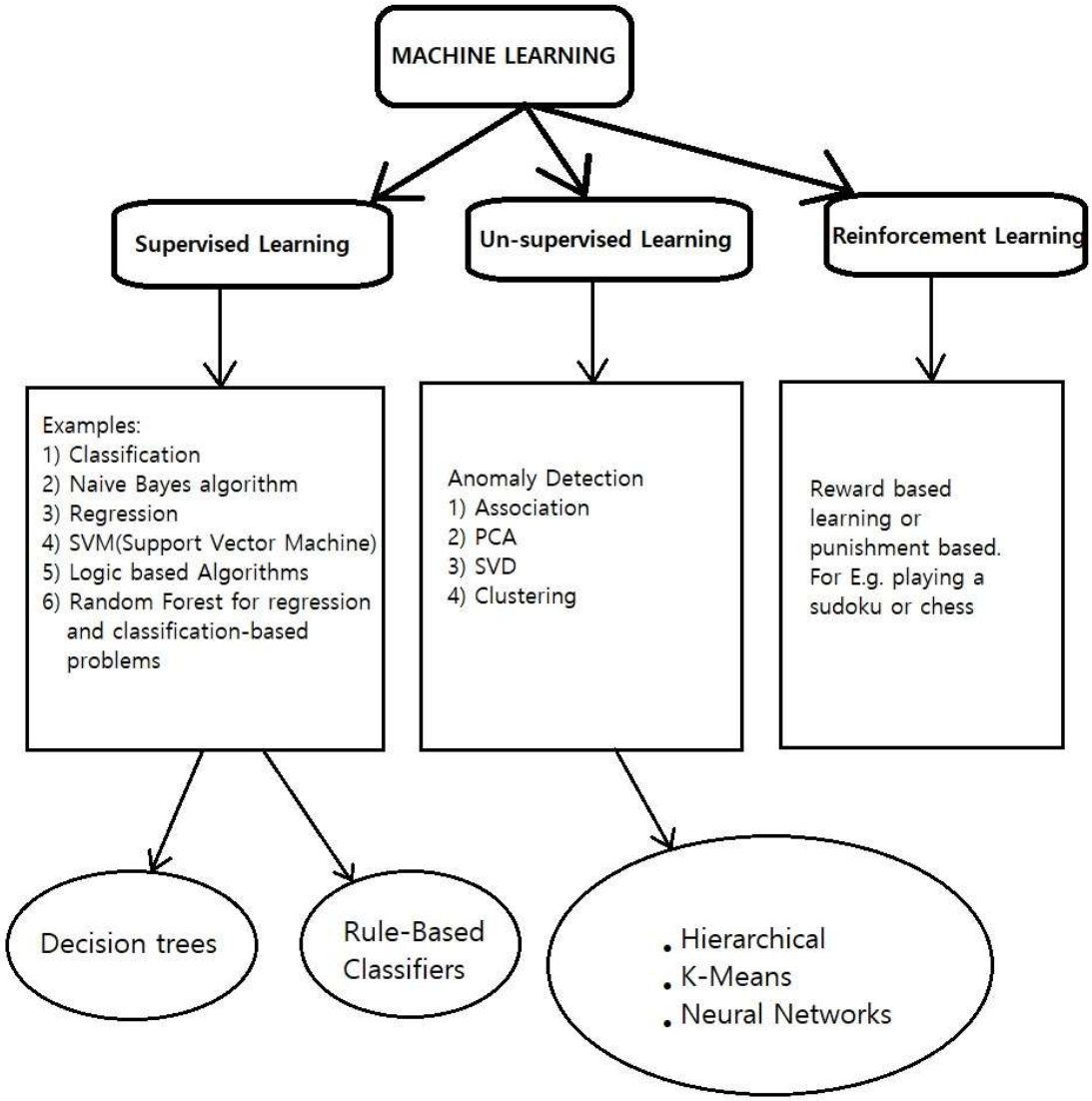

Figure 1.5: A classification of machine learning algorithms and their examples.

Machine learning is very sophisticated, and the way it operates varies based on the goal at hand and the method used to complete the task at hand. The foundation of a machine learning model, on the other hand, is a computer that examines data and recognises patterns, and then uses those insights to better execute the work that has been set to it. Machine learning may be used to automate any process that is dependent on a collection of data points or rules, including more sophisticated activities such as responding to customer service calls and assessing resumes.

The effectiveness of machine learning algorithms varies depending on the circumstance and the amount of human intervention/encouragement used. The four primary machine learning models are supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning. Supervised learning is the most common kind of machine learning.

The computer is given a labelled collection of data that allows it to learn how to do a human skill via the use of supervised learning techniques. This is the simplest model since it aims to recreate the process of human learning. The computer is given unlabeled data and is instructed to extract previously undiscovered patterns and insights from it. This is known as unsupervised learning. There are several methods through which machine learning algorithms do this, including:

Clusturing is a method of grouping data points together that involves the computer searching for and grouping comparable data points together (forming "clusters").

Density estimation is a technique in which a computer uncovers insights by examining the distribution of data in a data collection.

Detection of anomalies in a data set, in which the computer detects data points within a data collection that are statistically significant in comparison to the rest of the data.

A statistical technique known as principal component analysis (PCA) is used to examine and summarise data sets so that they may be utilised to generate accurate predictions using a computer.

The computer is given a batch of partly labelled data and is instructed to do its job using the labelled data in order to grasp the parameters that should be used to analyze the unlabeled data.

With reinforcement learning, the computer watches its environment and utilizes the information it gathers to discover the optimal behavior that will reduce risk while simultaneously increasing reward. A reinforcement signal is required in this iterative strategy in order to assist the computer in determining the optimum action to take at each iteration.

Machine learning (ML) has also become more crucial in today's digital environment, helping to find patterns in the vast amounts of data generated by the gadgets and sensors that are utilised in our daily lives. Applications of machine learning have improved a

wide range of sectors that are directly related to our everyday lives, such as education, economics, government, healthcare, security and surveillance, and so on and so forth. Its uses may also be broadened to include assisting in the digitized learning in the course of pandemic outbreaks.

These two diseases, SARS and MERS, are both caused by Corona viruses, which are a broad viral family that may cause a simple cold to more serious infections like SARS and MERS.. Transmission of MERS and SARS is facilitated by coronaviruses such as MERS-CoV and SARS-CoV As of 2012, MERS has only been discovered in Saudi Arabia, whereas SARS had been discovered in 2002. Virus Corona (SARS-COV-2) was discovered in Wuhan, China, and it is responsible for transmitting SARS to people.

China's Regional Office of the World Health Organization (WHO) was notified on December 31st of the first report of a pneumonia caused by an unknown illness that had been detected in Wuhan. As a result, the number of corona virus cases has climbed, as has the number of people who have died as a result of the infection. Corona virus spreads from one area to another over the whole nation in less than a month. COVID-19 was recognised by the World Health Organization on February 11th (WHO).

In March 2020, schools were shuttered throughout several countries as a result of the COVID-19 outbreak, leaving teachers with no option except convert their lessons to virtual learning settings. A huge international issue took place as a result of this occurrence. Identity and teaching quality research has identified a critical incident as an unrealistic expectation that hinders the progress of the schedule and, by surpassing a certain emotional limit, tends to put one's identity in jeopardy, forcing the teacher to reevaluate his or her own beliefs, techniques, or feelings. Due to the fact that they allow us to analyse our fundamental ideas, these events may be effective instruments for training, as well as for changing teaching and learning processes.

The methodological approach used in this thesis covers the whole hypothesis given in the subcategories:

- Specified requirements,
- User perceptions,
- Acceptance Testing, and others.

Each of these three subsections contains critical factors such as:

- standard data,
- standard content,
- standard device,
- offering service,
- user-friendly,
- expectancy value,
- application level of satisfaction,
- sense of mobility,
- user motive,
- uses of digitization, and
- real-world m-learning usage.

The purpose of using Machine Learning in this research is to utilize ML to construct a model for assessing students' perceptions in the way of digitizing education during Covid19, with the goal of similar digital instructions. Students at school, college, and other levels of education are the subjects of the study. The goal is to determine whether or not students are capable of interpreting learner perspectives in the context of mobile education.

1.4 THESIS OBJECTIVES AND RESEARCH CONTRIBUTION

One of the primary goals of this thesis is to lessen the influence of COVID-19 on diverse sectors such as supply chain management, educational institutions, and other similar organizations. The overall goal of the current study endeavor is to "Mitigation of COVID-19-like Challenges by the Use of Machine Learning and Blockchain Technologies." In order to better understand the challenge at hand, it has been broken down into smaller goals, which are as follows:

1.4.1 RESEARCH DIRECTIONS IN BLOCKCHAIN

The development of a framework for dealing with COVID-19-like difficulties via the use of blockchain technology The COVID-19 testing kit has been validated using blockchain technology, which we developed. With the help of the following steps, we

attempted to categorize the previously mentioned problem.

1) Learn about the testing kit authorization procedure or flow by reading the following: - Learn about the testing kit SCM flow by consulting a variety of sources, including which parties are necessary and what information is to be used.
2) Selecting the most appropriate platform for implementing the solution: - The network that we use offers the advantages of both centralized and decentralized technology, which we discovered via our analysis of the numerous platforms that are accessible for the blockchain platform.
3) Implement the solution: By putting the suggested framework into action, the performance of the system will be assessed based on a variety of metrics that compare the conventional and proposed frameworks.

1.4.2 RESEARCH DIRECTIONS IN MACHINE LEARNING

A portion of this thesis is dedicated for the purpose of utilizing machine learning to construct a model for assessing students' perceptions in order to digitize education during Covid19, with the goal of digitizing instruction. Students at school, college, and other levels of education are the subjects of the study, among others. We also developed a machine learning-based model for analyzing the mobile-based learning culture that exists among university students. We're also attempting to determine whether elements of students' institutional information could have an impact on the outcome of the mobile learning study. The research does not take into account external factors that may have an impact on results, such as the quality of the service or the quality of the material. Our motive is to determine whether or not students are capable of interpreting learner perspectives in the context of mobile education.

The primary objective behind a portion of this thesis is to: -

1) Determine the most appropriate machine learning based technique for analyzing, to perform statistical analytics.
2) Creating a machine learning based model that can perform accurate analysis of data.
3) Determining the characteristics that influence the analysis of student-centric data from educational institutions.

Another component of this research is the development of a machine learning-based model for examining the mobile-based learning culture prevalent among college and university students. We're also attempting to determine whether attributes of students' institutional information could have an impact on the outcome of the mobile learning study. The research does not take into account external factors that may have an impact on results, such as the quality of the service or the quality of the material.

1.5 THESIS OUTLINE

This thesis consists of five chapters:

Chapter 1: In chapter 1 we have provided the Introduction of blockchain and machine learning which further adds the motivation, thesis objective and research contribution.

Chapter 2: The chapter 2 elaborates the background of the research areas investigated and describes the related work performed in the various sectors viz., Healthcare systems, transportations, Educational institutions, e-commerce etc.

Chapter 3: This chapter deals with design of a framework for dealing COVID-19 like challenges using Blockchain Technology has been proposed and it also includes results and analysis of proposed theoretical framework.

Chapter 4: In this chapter we have discussed design of a theoretical framework for the adoption of mobile learning during COVID-19 which also includes results and analysis of proposed theoretical framework.

Chapter 5: This chapter concludes this thesis by summarizing our work and suggests areas/issues, which can be explored in future.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter we have collected our studied research papers, book chapters as well as web resources. The details of findings of each paper have been briefed with a proper citation number to the references section of this chapter.

2.2 SURVEY ON BLOCKCHAIN IN SUPPLY CHAIN MANAGEMENT

Rather than relying on the trust of the people involved, Satoshi Nakamoto outlined a system for electronic transactions in [1]. Coins minted using digital signatures are a good starting point, but they don't prevent double-spending since they lack a means to verify the authenticity of the coin's owner. In order to solve this problem, a proof-of-work network, which preserves a public history of transactions and makes it computationally difficult for an attacker to manipulate the history if honest nodes have a majority of CPU power, was built The network has a long lifespan due to its lack of structure. Nodes work in unison and with the least amount of coordination possible. Given that the messages aren't aimed at any particular area, they don't need to be recognised at all. They only need to be delivered using the greatest technology available. It is possible for nodes to depart and rejoin the network at any moment, and the proof-of-work chain will be accepted as proof of what happened while they were not present. It is a way for individuals to show their support for genuine blocks and their disapproval of invalid blocks by using their computers to work on growing those blocks. All required laws and incentives may be implemented with the aid of this consensus procedure.

In [2], the authors have unearthed the fundamental notion of blockchain technology, as well as some of its most notable characteristics. The fundamental premise underlying the technology and tools utilized, such as Ethereum and Hyperledger Fabric in public and private blockchains, respectively, will be defined after this. The authors also produced a non-restrictive list of blockchain applications that included a wide spectrum of industries, from the financial to non-financial. Healthcare, education, real estate, and other non-financial industries are examples of non-financial sectors that exist. Their

report discusses the current COVID-19 epidemic, which is affecting people all across the world.

It is possible to employ up-to-date data to increase the identification of CT scans and to interchange the data between institutions while protecting patient confidentiality and security, as shown by the authors in [3,4]. Because of the wide range of data sets that must be processed, the normalisation strategy is used. Using Capsule Network segmentation and classification, as well as a strategy that can collaboratively train a global model using blockchain technology and federated learning, it is possible to detect COVID-19 patients in the wild. For the benefit of the scientific community, the authors have compiled data from actual COVID-19 patients. A large number of deep learning models were used to train and evaluate datasets, and their findings were presented in their publication. The accuracy of the Capsule Network has been maximised. Models that can learn from data or sources shared across several hospitals have been proposed. Hospitals are prepared to provide their private data in order to build a more global and better model for COVID-19 detection through lung screening, according to their proposed model.

In [4], the authors with the help of distributed ledger technology and smart contracts, they have developed a revolutionary framework for pharmaceutical supply chain management. When implemented on the Ethereum blockchain, smart contracts may assist achieve user privacy, data transparency, immutability and high availability. There is no single point of failure, no non-repudiation, real-time traceability of drugs, and demand supply management. The experimental findings and analysis of the suggested framework are quite promising, and they should be used to produce a proof of concept for the system under consideration. Demand prediction may be improved by experimenting with a variety of machine learning approaches in the future. Blockchain has a scalability problem, and as a result, the transaction speed under the suggested framework may be significantly reduced. Researchers are currently working on resolving this problem, and it is hoped that the suggested framework will be extensively used in the pharmaceutical industry in the near future.

A need for more widespread use of emerging technologies for detection, monitoring, and diagnosing has been argued by the authors of [5] despite the significant progress made in the application of emerging technologies in compressing COVID-19. This is

despite the significant progress made in the application of emerging technologies. Artificial intelligence models, GIS concepts, and Internet of Things applications all benefit from COVID-19 data's scope, availability and accessibility. There is a pressing need for the creation of a robust computationally intelligent model for the early differential diagnosis of COVID-19, as well, as the authors pointed out in their paper; Ethical framework and acceptable use of new technology should be examined in future research aimed at controlling the COVID-19 pandemic while protecting the privacy and security of individuals' personal information.

For Distributed Ledger Quality Control, the authors proposed a model in [6]. (SCQA). Blockchain-based supply chain quality management will be theoretically underpinned by this framework, which will be further improved, according to the authors. In addition, it serves as a foundation for the development of theories on the management of information resources in distributed, virtual organisations, especially distributed, cross-organizational and decentralised management theories. The framework will also be used to create an intelligent SCQI system for a real-world application.

They wanted to see whether they could come up with an original and imaginative way to detect previously unknown cases of coronavirus infection, which is why they conducted this study [7]. (COVID-19). The first blockchain-based system for discovering previously unknown coronavirus (COVID-19) cases and locations, as well as automatically calculating and forecasting the likelihood of transmission, was established as a consequence of this study. Governments, health authorities, and the general public will be able to use this new component of the framework to help guide important decisions that will have a lasting impact on their lives. They also wanted to see how a unique blockchain-based P2P-Mobile application design for all residents in a congested area may help them identify the source of infection... Other than that, the novel architecture of the proposed P2P-mobile app is designed to help governments and health authorities uncover previously unidentified instances of COVID-19 viral infection. Decentralized design, peer-to-peer connectivity, real time processing and time stamping characteristics of blockchain technology were used to construct a revolutionary peer-topeer system capable of tackling several COVID-19 viral propagation and dissemination difficulties. All four parts of the suggested architecture are now being developed and deployed as a new system that includes an Infection

Verifier Subsystem (IVS), Blockchain platform, P2P-mobile application, and the Mass-Surveillance System.

In [8], the authors' main work revolves around Collision resistance, preimage resistance, and second-preimage resistance which are fundamental principles of security for cryptographic hash functions that we will discuss. Their definitions relate to three fundamental notions, and they draw out all of the consequences and distinctions between these seven definitions within a concrete-security, provable-security framework. Given the concrete nature of their findings, they have demonstrated two sorts of implications: traditional and provisional, the strength of which is dependent on the degree of compression accomplished by the hash function. They also differentiate between two sorts of separations: conditional separations and unconditional separations. When creating counterexamples for their separations, they take care to retain the hash-function domains and ranges that have been defined; this eliminates certain pathological counterexamples and makes the separations more meaningful in reality.

In [9], the authors demonstrated that digital currency is already available, and many more smart contract methods are in the process of being developed. The design criteria that are critical for automating contract execution have so far come from disparate fields such as economics and cryptography, with little cross-communication: on the one hand, there is little awareness of the technology and on the other, there is little awareness of the best business applications. The notion of smart contracts is intended to acknowledge that these initiatives are aimed at achieving shared goals, which are all convergent on the concept of smart contracts.

In [10], their article provides a concise overview of some of the most prominent blockchain consensus techniques, which are often employed in private blockchains. The authors in this work have examined the many voting-based consensus mechanisms used in private blockchains, which will be useful in determining which consensus mechanism to adopt, based on the business requirements, which will have a direct influence on the performance of the blockchain. Researchers will find in their review of consensus methods and their attributes to be quite useful in someone's future research. Further investigation may be carried out by implementing several consensus comparisons with modifying the amount of loads and peers and evaluating them against some benchmark

in order to get the real performance indicator of the consensus that is being utilized in the comparison.

In [11], the authors have presented, explored, and officially defined the Ethereum protocol in this article. After studying it, a reader will be able to install a node on the Ethereum network and join other members of a decentralized safe social operating system by following the instructions written in their presented protocol. In order to algorithmically establish and autonomously enforce norms of interaction, contracts may be written and executed.

Here, Hyperledger Foundation, an open source community that is devoted to the creation of dependable frameworks, tools and libraries for enterprise-grade blockchain installations, is referred to in [12]. Based in England, the organization's headquarters may be located. One of the Linux Foundation's many global collaborations is a global group of experts from a broad range of fields, including banking, supply chains, manufacturing, and information and communications technology (ICT). These game-changing technologies are being created and marketed under the auspices of open cooperation and technical governance. Individual developers, service providers, government organisations, corporate members, and end users are all welcome to engage in the creation and promotion. Hyperledger's approach to hosting projects is comparable to that of the Linux Foundation, which uses a modular approach. At addition to Hyperledger Labs, the Hyperledger Foundation provides funding for blockchain projects in different phases of development, including stable code that is ready for deployment. The Hyperledger projects and organisations are available to anybody who wants to help advance the industry's goals of distributed ledger technology and smart contracts.

In [13], the authors in this paper claimed a utility of Dragon tokens (also known as Dragons) which will serve as a tokenized license for interacting with Dragonchain’s commercial platform services. Dragon tokens are a kind of cryptocurrency. The tokens will be issued and made available to the general public via an open sale. Dragons will be utilized by developers and organizations to engage with the Dragonchain commercial platform's goods and services, as well as with each other (e.g. launch nodes, provision smart contracts, access incubator dashboard, etc.). In addition, since the tokens represent a tokenized license with a monetary value based on utility service rights, they

will let people or organizations to be compensated on an open market for maintaining public or private nodes for network consensus.

In [14], the authors presented Corda as a decentralized database created specifically for the financial industry. It enables the distribution of a single data set over a large number of nodes that are mutually distrusting of one another, with smart contracts running on the Java Virtual Machine (JVM) providing access control and schema definitions. A revolutionary continuation-based persistence framework aids developers in the coordination of the flow of data across a network of computers and networks. An identity management system guarantees that all parties are constantly aware of who they are dealing with in their transactions. With relation to distributed consensus systems, notaries provide algorithmic agility. Additionally, the system runs without the need for mining or a block chain. For the purpose of modelling financial logic, a standard type system has been developed. Because the design is based on binary protocols with length-prefixed buffers throughout, it is designed to avoid the systematic use of common buffer management exploits. It supports the integration of secure signing devices for transaction authorization, secure enclaves for transaction processing, composite keys for expressing complex authorization policies, and is based on binary protocols with length-prefixed buffers throughout, to avoid the systematic use of common buffer management exploits. It is possible for users to analyze ledger data that pertains to them by making standard SQL queries against established database engines, and they may create complicated multi-party transactions with relative simplicity in programming languages that they are already acquainted with. Finally, the platform defines standard methods for integrating the global ledger with financial infrastructure like as high-performance markets and netting services, among other things.

Instead of just documenting transactions, the authors explain in [15] that Corda was built to store and enforce business agreements between trade partners, unlike the bulk of contemporary distributed ledger and blockchain technologies. So it uses an innovative data distribution and transaction semantics approach while stressing distributed ledgers' value to companies, such as trustworthy execution of contracts in an automated and enforced way. While following to stringent governance requirements, multiple apps and services may operate on a common layer of identification and consensus, business logic and defined data definitions thanks to the Corda network. It is possible for companies to

build up a Corda node infrastructure that allows them to trade with many sets of trading partners simultaneously and with high degrees of anonymity. Various competing notary consensus pools composed of a range of providers will be made available to the ecosystem's consumers in a transparent and open method, allowing them to govern the ecosystem for themselves. You may use the same oracle services for several applications. Diverse apps, each developed for a particular purpose, may be deployed today to address specific challenges; yet, in the future, contracts and other information kept by various applications may be connected in creative ways for purposes that are now inconceivable.

[16] refers to a website by the name of One of the Department of Health and Human Services' most important components is the Centers for Disease Control and Prevention (CDC). The Centers for Disease Control and Prevention (CDC) distributes resources in an appropriate way. When it comes to responding to public health emergencies, CDC says they have everything they need, including the personnel, resources, and expertise to handle any situation that arises. As the national health protection agency, the Centers for Disease Control and Prevention (CDC) works around the clock to protect Americans from both domestic and international health and safety threats. In order to keep our nation safe, the Centers for Disease Control and Prevention (CDC) helps. Public health STEM programmes for kids in elementary school through high school are available via the Centers for Disease Control and Prevention (CDC). According to the website, there are a variety of activities and materials to choose from. The museum uses award-winning exhibits and cutting-edge programming to teach visitors about the significance of public health while also showcasing the CDC's rich history and tremendous accomplishments. The Centers for Disease Control and Prevention (CDC) has been preparing healthcare workers, learning more about how the disease spreads, and assisting state, local, tribal, and territorial governments who are on the front lines of public health protection since January 21, 2020, when the pandemic was first announced.

The Wikipedia article referenced in [17] contains statistical data that was utilised in this work.

An explanation of the testing kit and test procedure may be found in [18]. According to the website, COVID-19 (Corona Virus Illness) is a newly discovered coronavirus-

caused infectious illness. COVID-19 IgG and IgM antibodies may be detected in human serum, plasma, or whole blood with this test. An immunoassay for COVID-19 antibodies in human serum, plasma, or whole blood is the COVID-19 IgG and IgM Rapid Test (Serum/Plasma/Whole Blood).

The Indian government's medical website is referred to in [19] for information dissemination. An additional set of information concerning the ICMR website: Biomedical research creation, coordination, and promotion are all the responsibility of the ICMR, a national body headquartered in New Delhi. It was founded in 1897, making it one of the oldest medical research institutions in the world. There are two opposing demands on the part of the Indian Council of Medical Research (ICMR): one, scientific improvements in biomedical research, and the other, a desire to find practical solutions to the country's health problems. However far it has gone, the International Council for Medical Research (ICMR) recognises that it still has a long way to go in its pursuit of scientific accomplishments and health-related goals since its foundation as the International Research and Development Foundation (IRFA).

It describes R3 in [20], a key source of direct, digital communication in regulated areas where trust is essential. According to the website, the "Power of 3"—R3's trust technology, connected networks, and regulated markets expertise—can be used to drive market innovation and improve operations in industries like banking, capital markets, global commerce, and insurance by developing multi-party solutions on their platforms. R3 has allowed enterprises to fully realise the promise of trusted direct collaboration since being one of the first firms to create both the only private, secure, and scalable distributed ledger technology (DLT) platform intended for regulated markets. The DLT production ecosystem we run unites approximately 400 organisations from the commercial and government sectors, making it one of the largest in the world.

[21] is a useful resource for software developers and their teams. The premier Java integrated development environment, IntelliJ IDEA, is developed by JetBrains, a cutting-edge software supplier that specialises in the creation of intelligent development tools. There is a software development company in the Czech Republic called JetBrains (formerly IntelliJ Software), which makes tools for programmers and project managers to use. As well as providing IDEs for the programming languages Java and Groovy and Kotlin and Ruby and Python and PHP and the domain-specific language SQL (for

example), the company also offers IDEs for C and Objective-C as well as Go, JavaScript and the languages Groovy and Kotlin as well as Ruby and Python. In 2011, the company created a Java virtual machine (JVM)-compatible programming language called Kotlin.

In [22], an API platform called Postman is referred to as the website where APIs may be created and used. Postman makes it easier to collaborate on APIs and speeds up the API development process, resulting in better APIs in less time.

The COVID-19 screening and diagnostic system shown in [23] is driven by artificial intelligence. In order to take advantage of the low-latency network, multi-mode transmission, and increased mobile broadband, the system was implemented on a B5G network (eMBB). The COVID-19 transaction was able to process and transmit data securely thanks to the blockchain. Edge devices with high power capabilities were used to handle data from a hospital, allowing DL models to be evaluated and fine-tuned in a more controlled setting. For any communicable disease, not only COVID-19, the proposed COVID-19 screening and diagnostic procedure may be tailored to suit individual demands. It will be required to filter out non-COVID-19 patients and manage private patient data in the edge to protect patient confidentiality in order to reduce patient congestion in the hospital.

On the basis of blockchain technology, the authors of [24] suggested a system for the supply chain management of COVID-19 testing kits in healthcare Using R3 Corda, they illustrated how SCM may be implemented by identifying the various parties involved. A wide variety of tools and working conditions were also discussed. Expanding the work can be done through a number of different avenues such as creating a CorDapp that does not rely on any third-party APIs, creating a new unique identifier that is safer, increasing the number of intermediates in the chain for greater transparency, or simply adding new features like the ability to upload files to the system. Although the developers of COVID-19 would like that the project come to an end as soon as feasible, this does not rule out the potential of employing this framework in other areas and in other ways in the future.

Symptoms of COVID-19 infection, as well as prevention methods, are discussed in [25]. Additionally, the cutting-edge technology used to combat COVID-19 was brought

to light. The Internet of Things (IoT) may be used to connect medical equipment to the internet and provide remote treatment to infected patients, among other things. In addition, a variety of additional technologies are included. Global attempts to combat COVID-19 and other pandemics will benefit from new technologies like the Internet of Things (IoT), artificial intelligence (AI), blockchain, and 5G, among others.

2.3 SURVEY ON USING MACHINE LEARNING FOR DIGITIZED EDUCATION

In [26], a single pilot effort to study the use of online learning in Nigeria during the COVID-19 pandemic is reported. Nigerian students of higher education, as per the paper, have a low acceptance of online learning technology and prefer instead the traditional classroom learning setting, which places them in the "Laggards adopter categorization" of the diffusion innovation theory, which is the group that is highly conservative in their thinking. The failure of online learning in Nigeria during the COVID-19 pandemic in 2015 was mostly due to two crucial areas of the national infrastructure: power (i.e. electricity) and internet connection (and accessibility). These two variables are important to the success of online learning in Nigeria.

The findings in [27] are similar to those of other studies that looked at a wide range of variables. On the other hand, this study provided a hybrid research model at COVID-19 that included the TAM model with the UTAUT model as well as the De-Lone and McLean model, both of which are critical in understanding students' views on and perceptions of mobile learning. It is proved that the research model works by employing six different classifiers, all of which are implemented in Python using Sci-kit learn, such as Logistic Regression, Decision-tree classification, Nave Bayes, Random Forest, SVM, and KNN classifiers. Perceived ease of use and usefulness were shown to be the most accurately predicted variables among all other constructs, with an accuracy of over 93% in certain cases. Students' desire to use mobile learning is influenced by three essential determinants of mobile learning adoption. Other examples include service quality and customer happiness, which are predicted with an accuracy of up to 81% by a variety of classifiers. It is clear that students' perceptions of utilising mobile learning are influenced by their behavioural intention and their genuine intention to utilise mobile

learning. Nearly ninety percent of the forecasts come true. According to the results of the inquiry, Random Forest and KNN are the most successful algorithms for predicting mobile learning constructs when compared to other classifiers in the proposed model. To predict the components, only a small number of studies have employed machine learning techniques. So the results and analysis of student perceptions during COVID-19 in terms of mobile learning adoption using machine learning algorithms let us generalise the results in terms of student acceptance of mobile learning. As a consequence of the findings, students may be more inclined to turn to mobile learning for academic purposes due to a better understanding of the most critical aspects to take into account when creating mobile learning platforms. Students' impressions may be gleaned from this information in order to help teachers improve their teaching methods via mobile learning.

As a result of a coronavirus pandemic, all universities in Poland were compelled to transition to distance learning in May–June 2020, and this research is based on a survey of full- and part-time students at the University of Economics in Katowice (Poland). In order to have a better understanding of students' impressions of distant learning and the University's use of information technology, a survey was conducted. Study participants reported moderate levels of self-efficacy and belief in the benefits of distance learning, as well as a high level of comfort with computers and the internet, and they plan on using it often during the course of this semester, according to the findings of this study. The students, despite their positive feelings towards distance education, would prefer to return to a traditional classroom. In the event that the COVID-19 scenario necessitates the continuation of higher education institutions' online operations, this research will be an essential contribution to policymaking. Despite this, the research has a number of flaws since it only looked at one institution in one country. To acquire a fuller understanding of the pandemic's impact on higher education, comparative studies should be conducted.

In [29], the authors noted that COVID-19 brought a significant transformation in the Indian educational system. Despite the fact that it has presented countless problems and provided innumerable chances, it has also made progress. The Indian government and representatives from various educational institutions have addressed the possibilities of e-learning via the use of various digital technologies in order to deal with the current

COVID-19 situation. India is not fully prepared to use digital platforms to provide education to every part of the country. Universities and the Indian government have been working together for years to find a solution to the country's educational problems. The first step should be to use digital technology to create a benefit point for the millions of young children in India who are now enrolled in school. A significant amount of time is required of educational institutions to support their knowledge and information technology infrastructure in order to be prepared to deal with COVID-19 circumstances. In a contagion situation, the notion of "work from home" becomes even more important in order to reduce the spread of COVID-19. It is imperative that India develops innovative measures to guarantee that all children have a viable opportunity to study throughout the epidemic COVID-19. The practise of e-learning is very beneficial to the pupils, and it should be maintained after the lockdown.

The reference in [30] is an editorial page of Eurosurveillance editorial team (ECDC), based in Stockholm, Sweden. The editors also noted that one big issue which is the potential for the virus to move to nations with poorer health systems and who are ill-prepared to deal with it, as well as the significance of 'preventing the spread of the virus and ensuring a methodical and evidence-based response'.

In [31], the authors have shown that global higher education has been impacted by the COVID-19 pandemic, which resulted in thousands of school closures in a relatively short period of time to implement social distancing measures in response to the outbreak. Institutions of higher learning, especially those in the Philippines, are confronted with a variety of issues in their systems of planning for instruction, execution of instruction, and evaluation. On a more positive side, the worldwide pandemic has provided possibilities for the nation to modernise its educational delivery methods and shift its focus to future technology, to name a few. As a result, higher education institutions must grasp the opportunity to improve their evidence-based procedures, make mental health-related services more accessible, and adapt their curricula to meet the requirements of a rapidly changing society.

A mobile learning system in higher education was explored using the UTAUT model, which was utilised to define the main variables that determine its acceptance, as shown in [32] by the authors. Following this study, a new model was developed to help students adopt a mobile learning system, which has emphasised the most important

variables that influence students' acceptance. According to the conclusions of this survey, mobile learning use is increasing, as shown by the following results. External factors such as information quality, trust, and technical self-efficacy play a significant role in the adoption of mobile learning systems. For starters, the research shows how crucial it is for students to be familiar with and comfortable using mobile learning systems, as well as having access to resources and systems that work together. Third, the data show that students' expectations of success, effort, and favourable conditions all contribute to the adoption of mobile learning systems in terms of the factors in the UTAUT model. In contrast, it doesn't seem that the social influence is all that important. The perceived security of mobile learning systems had a significant influence on improving students' trust, resulting in an increase in their acceptance. This means that students will be more willing to accept and use mobile learning technologies as their level of trust in the system develops.

In [33], the authors in this paper have shown that the TAM Model serves as the foundation of the study, and its goal is to incorporate new variables into the model, such as system quality, content quality, information quality, and service quality, in order to assess students' behavioural intentions to use mobile learning platforms in the United Arab Emirates.

In [34], the authors here emphasises to educational theory and practise are mapped out, encouragement of students' involvement with learning in virtual reality, which necessitates the development of a learning activity outline that includes clearly stated phases of learning and its objectives. This clarifies the environment in which learning will take place, including the characteristics, degree of understanding and motivation of learners, the tutors' roles and responsibilities as well as the restrictions and desired pedagogical method. All of the mini-learning tasks that must be done, as well as the tools and resources that must be used, must be listed. In order to allow for interactions with peers, instructors, and course materials while also guaranteeing that feedback is accessible on a regular basis, all activities must be coordinated. E-learning must be integrated into the strategic plan and budget of the institution in order for it to be effective in both developed and developing nations. Specific targets must be established for e-learning efforts in both developed and developing countries. As e-learning technology is used across the board, it is necessary to design and implement

development programmes. It is critical to create a dedicated office or centre for the administration of e-learning, as well as to design and execute a plan for identifying instructors and students who need more training. E-learning continues to be a problem in need of a solution. However, in order to enjoy the benefits, it is essential that the process of implementation be understood and followed to the letter. When it comes to e-learning efforts, developing-country institutions and smaller institutions in developed-country institutions tend to lag behind. It is possible that this is related to the high initial cost of developing and deploying e-learning. The provision of e-learning services via a number of European (Horizon2020) and national (UK Royal Society and DFID) capacity-building initiatives might be outsourced and/or implemented in conjunction with enterprises and other institutions as a feasible option. E-learning will be around for a long time because it has the potential to increase access to higher education, broaden involvement in higher education, and contribute to improvements in education, life, and society for individuals and society as a whole. Institutions would be required to establish and execute the appropriate balance of rules and governance for the adoption of e-learning, as well as to make significant investments in their faculty and students.

In [35], specifically, the goal of this study was to create and evaluate new assessment scales for perceived usefulness and reported ease of use, two different factors that were believed to be predictors of computer use. There were a number of positive outcomes from this endeavour. In addition to having good psychometric features, the new scales were shown to have substantial empirical connections with self-reported measures of use behaviour. In addition, some new insights were gained into the nature of perceived utility and ease of use, as well as their roles as predictors of user acceptability, were discovered.

In [36], the authors in this studied about virtual reality contact with a simulated environment may be a fair and beneficial alternative for real-world experience. Design efforts can be lowered by basing technology usage on relevant learning theory and research findings (e.g., constructivist learning theory). Based on the findings of this case study, six implications have been identified that may be of use to educators when developing virtual reality learning systems.

O'Malley [37] described Mobile learning as any mode of education that occurs when the student is not at a planned position, fixed place, or education that occurs when the student opts for education possibilities given by portable technologies.

Traxler [38] explained M-learning is perhaps being described as an educational procurement where the individual or authoritative technologies are handheld or palmtop tools. This description means that education will incorporate personal digital assistants (PDAs), mobile phones, also their peripheral devices.

David [39] extended the technology acceptance model to discover user support for movable learning employing this model. The technology acceptance model (TAM) is based on parameters that are perceived interaction, perceived easiness of usage. In this research, it adds an external variable perceived usefulness to the model for exploring the acceptance of mobile learning. Further, it has limitations of questionnaire responses from high students and very few by university students.

Seyyedreza [40] in their study implement the mobile learning-based education using the conceptual model by combining TAM and ml approaches in the Payamnoor University of Iran. In this study four factors like environmental characteristics, student behavioral characteristics, educational and technology infrastructure, education system failures with the ease of use of mobile learning for gender-based learning were considered. Thus, four hypotheses and eight sub hypotheses were prepared to show that there is a direct and positive relationship of all the four factors with the acceptance of ml and there is no difference between the ml and acceptance of m-learning based on gender.

S. A & Economides [41] aimed their study in determining the factors that influence students in adopting Mobile-based Assessments. It proposed a Mobile-based Assessment acceptance prototype based on the technology acceptance model (TAM) by adding external factors like Perceived Trust, Content, Cognitive Feedback, User Interface, Perceived Pervasiveness Value, and percentage variance on the Behavioral Purpose to utilize mobile-based assessments in senior level secondary school.

Chuchu and Ndoro [42] proposed the conceptual design based upon the TAM model to examine the learner's opinion towards the use of mobile applications used as learning tools in higher education of South Africa. This study used SPSS, AMOS 23, structural equation modelling technique (SEM) to analyze the result. It analyze the TAM factors

only to showed a positive attitude towards the acceptance of portable learning programs, and the increased use of platforms increases the use of mobile learning in the institution.

Alshurideh [43] proposed the model which is an extension of the TAM model by adding important quality factors such as content quality, quality of system, information quality, service quality. In his study the attitude towards the use of portable learning programs based on the system quality and user interface lead to high user intention and the increased use of m-learning programs in developing countries such as UAE. It collects data from 221 students and analyze using structural equation modelling technique.

Chavoshi and Hamidi [44] proposed a comprehensive model using the technology acceptance model (TAM) and unified theory of acceptance and technology model (UTAUT) to study the factors like technological, pedagogical, group, social and individual to show the influence of students towards m-learning acceptance in higher education in Iran. The proposed model was analyzed using the partial least square-artificial neural network (PLS-ANN) technique which analyze both linear and non-linear relationships of the model.

Shamsuddin [45] used the STEEPV analysis technique to identify the factors and the UTAUT model to measure the level of m-learning acceptance in public university Malaysia. This study showed that the technological factor is the most important factor among all the factors in influencing students to adopt mobile learning. Data was analyzed using SPSS version 23 tool. Moreover, the attitude and behavior intention of student's properties is an essential constituent in the increased level of mobile learning acceptance. But results showed that internet was the main reason for less adoption of mobile learning in Malaysia despite the positive perspective.

Al-Adwan [46] proposed the empirical framework modifying the constructs of previous models to determine the acceptance of m-learning. It aimed at investing the student's behavioral intention towards adoption in developing countries like Jordan in higher education. It studies the different factors such as relative advantage, complexity, social influence, perceived enjoyment, and the self-management of learning. This study employed SEM technique to examine the relationship between constructs and Smart PLS3 was used to conduct statistical analysis.

Kaliisa [47] proposed a theoretical framework as a UTAUT model by adding variables to it for calculating the variance of mobile technology use. This study reflects the

student's attitude towards its use and challenges during m-leaning. It gives a deep insight into the review of m-learning adoption in developed and emerging countries like Australia and Uganda. Mobile learning is widely seen in developed countries like Australia more than in developing but, it shows that students have a positive attitude towards using laptops for mobile learning. It shows that 52% strongly agreed and 42% agreed towards mobile learning use. It used SPSS tool for data analysis and both qualitative quantitative approach is used.

Hafedh [48] proposed the model based on UTAUT model and TAM model to predict m-learning acceptance in developing countries. Neural network (NN) modelling technique was the used to predict the adoption of mobile learning among learners in Oman. This study shows the enjoyment learning is the major factor responsible for the enactment of mobile learning amongst learners in Oman.

Kapasia, Nanigopal [49] assess the impact of COVID-19 on undergraduate student's education in West Bengal, India. The research study used SPSS tool to analyze the data collected using google form. Result findings showed that 70% learners are involved in mobile learning. It also shows that Student's face difficulty such as infrastructure technical issues, and environment for learning.

Said Salloum [50] proposed an extended TAM model and TPB to analyze university student's intention towards mobile acceptance of mobile learning applications during COVID-19 in UAE. This study suggests the use of hybrid approach PLS-SEM and machine learning algorithms in WEKA to analyze the research model. Results showed that J48 classifier with accuracy 89.37% outperforms than other classifiers.

Biswas [51] analyze the student's perception towards mobile learning during COVID-19 in Bangladesh. The study employs descriptive statistics using SPSS and survey method to collect the data. Results showed that 70% students show positive attitude towards the mobile leaning as a mode of learning during COVID-19.

Mohammed Amin Almaiah [52] proposed hybrid model using TAM factors and TUT model constructs such as perceived enjoyment, efficiency, effectiveness and utilization. The survey questionnaire distributed in five universities of Jordan. The hypothesis proposed are validated using machine learning prediction algorithms in WEKA. Random Forest and IBK algorithms perform best among all the classifiers with an

accuracy of 81.3%. Factors show the positive relationship towards predicting mobile learning acceptance.

Since its introduction in 2016, Twitter has grown to be one among the most famous social media platforms. Since then, the site has served as a vital source of data for academics and industry professionals conducting social media research. Researchers have used the platform to explore public mood and perspectives on a variety of topics, including the current COVID-19 worldwide epidemic, supply chain (Chae, 2015), and public health (Kabir & Madria, 2020). The majority of these academics analysed or examined data acquired via Twitter and various other social media sites using various machine learning approaches.

Dubey (2020) examined the sentiments of tweets from various countries using sentiment analytic methods such as partiality and polarity. The researcher went on to analyse the emotions expressed in tweets out of each country. The study's findings found that, while the majority of the world's population is enthusiastic about combating the virus, there is also fear, rage, grief, disgust, and astonishment.

In addition, Sharma et al. (2020) created a panel to track disinformation on the Twitter website by collecting data streams using the Twitter API in their study. The dashboard aided the researchers in analysing COVID-19-related social media discussions as well as the quality of material posted on the platform. The research revealed user accounts as well as the spread of misinformation across countries. The researchers also looked at public opinion in different nations about preventive measures including social distance and working at home.

Word frequencies and topic modelling using Latent Dirichlet Allocation were utilised by Abd-Alrazaq et al. (2020) in order to analyse data obtained from the Twitter platform in order to find relevant discussion topics.

In order to study changes in Twitter behaviour and attitude surrounding the COVID-19 outbreak, Medford et al. (2020) utilised hashtags associated with COVID-19 to gather data from Twitter. The authors used phrases like sickness prevention, immunisation, and racial prejudice to assess emotional intensity and the most common feelings. Topic modelling was also utilised to keep track of the different topics of discourse that occurred throughout time.

In addition, Dickinson and Hu (2015) used stock-related tweets from the Twitter site to forecast a sentiment value. Emotions and the patterns of a company's worth are linked in a real-time streaming environment. The study discovered significant links between pricing and emotion for a slew of specific firms.

The application of machine learning to analyse public opinions towards online learning during the present COVID-19 epidemic is a first in the globe, despite the fact that there have been several sentiment analysis studies utilising data gathered from Twitter on a wide range of subjects.

The table 2.1 is a comprehensive table representing the key-points in the research articles.

Table 2.1: Comprehensive table representing the key-points in the research articles.

Author	Year	Research Finding/Study
Ijazul Haq[36]	2018	• Proposed a model for the Pharmaceutical Industry for preventing counterfeiting of drugs using permissioned blockchain technology. • Explains traceability of drug supply. • The model includes participants like Nurse, doctors, and Patients.
Sandip Jangir[37]	2019	• Proposed a platform for SCM of pharmaceutical utilizing smart contracts and distributed ledger. • Ethereum platform is used. • In terms of No single point of failure, real-time tracking of drugs, Data transparency, Immutability, User Privacy, High availability, and Non-repudiation proper analysis and experimental results have been taken.
Tsung-Ting Kuo[38]	2018	• Proposed a framework that was used to

		preserve healthcare data called ModelChain. • Built using the integration of Machine learning and private blockchain network. • Also developed a new proof-of-information algorithm to find the sequence of blockchain-based online machine learning
Si Chen[39]	2017	• Proposed a framework for supply chain quality management using blockchain technology that provides a theoretical basis to intelligently implementing management across system • Can be implemented in the real-world application.
Mohamed Torky[40]	2020	• Proposed a method for detecting unknown COVID-19 infected cases using blockchain technology. • There are four main components of the system:- a) P2P mobile Application b) Mass-Surveillance System c) Blockchain Platform d) Infection Verifier System
Hua Wang[41]	2018	• Proposed a framework for sleep stage classification. • Using the concept of edge strength of the visibility graph technique from EEG signals.
Wang H.[42]	2018	• Discusses to secure Big Data in healthcare or EHD in terms of privacy. • Also discusses the open challenges and various techniques.

		• Privacy-preserving approaches are divided into cryptographic and non-cryptographic approaches.
Muhammad Ashad Kabir[43]	2018	• Discusses a method for identifying major depression among users using social media application called Facebook. • Considering the factors such as temporal process, emotional process, and linguistic style. • Using Machine Learning algorithms.
P. Vimalachandran[44]	2017	• Proposed a system called "Log-in-pair" to resolve the issue of unauthorized access for the PCEHR. • Only a superuser gives access to all other users. • Uses both RBAC and PBAC access model principles.
Shekha Chenthara[45]	2019	• Discusses the existing cryptographic and non-cryptographic e-health cloud preserving mechanisms to secure privacy. • Also discusses the various opportunities and issues for advanced research related to secure EHR.
Donghwi Park[46]	2020	• Discusses various solutions to conquer the COVID-19 pandemic using blockchain technology. • First, by storing and reporting the data of COVID-19 infected patients to safe from hacking. • Second, by making the transparent system for the COVID-19 donation fund. • Third, stay away from false information

		regarding the prevention of symptoms. • Last, face-to-face contact can be reduced by blockchain as all diagnosis reports are stored online.
Anshuman Kalla[47]	2020	• Discusses the importance of blockchain to fight against pandemics by implementing various use cases such as supply chain management, contact tracing, automated surveillance, disaster relief, manufacturing management, patient information sharing, e-government, online education, immigration management, and contactless delivery. • Also, discuss performance metrics and various challenges that can be encountered and their possible solutions. • Challenges can be security, scalability, privacy, latency, throughput, etc.
Dabor Resiere[48]	2020	• To combat COVID-19 describes the implementation of medical cooperation using blockchain technology. • Improving global health by permitting global access to smart contracts and financing systems, protecting patient privacy, guaranteeing new features for patient's referrals through the region, and enabling new principles for reimbursement and payments.
Gari Singh[49]	2020	• Under the name of IBM, built a distributed ledger technology to convey data about the COVID-19 pandemic in collaboration with WHO and other technical firms called Mipasa.

Cornelius C. Agbo[50]	2019	• Shows an extensive study of blockchain in the healthcare industry including use cases, applications, benefits, limitations, etc. • Uses research methodology called PRISMA. • Use cases include electronic medical records, biomedical research and education, drugs and pharmaceutical SCM, remote patient monitoring, health data analytics, etc. • Challenges include interoperability, scalability, latency, speed, privacy as no proper standards are followed that leads to open research.
Anjum Khurshid[51]	2020	• Describes how blockchain provides solutions to data-related trust problems with its cryptography-based security and distributed trust networks. • Describe an innovative way to deal with the COVID-19 crisis, and shows examples of the challenges faced in tracking medical supplies by existing technologies.
Dounia Marbouh[52]	2020	• Reviews various opportunities and applications of blockchain to deal with the COVID-19 pandemic. • Develop a tracing platform for COVID-19 data that are retrieved from numerous external sources. • The proposed solution is cost-effective and guarantees data transparency, security, integrity, and traceability among organizations.
Santosh Nandi[53]	2020	• For building supply chains more transparent, resilient, and sustainable they provide insights

		from the COVID-19 pandemic. • Insights include supply chain to requiring to develop LAD characteristic i.e. localization, agility, and digitization.
Hao Xu[54]	2020	• Propose a model BeepTrace which is a privacy-preserving contact tracking scheme based on blockchain technology. • Bridging the gap between authorized solver and patient to desensitize the location and user ID information. • Provides higher security with the advantage of a globally accessible and user-friendly environment.
S.H. Alsamhi[55]	2020	• Overviews the operation of multi-robot collaboration for dealing with COVID-19 pandemic and upcoming pandemics using blockchain technology. • Numerous homogenous and heterogeneous robots are needed to perform different tasks for different purposes. • Robots can help in a task in like disinfection, temperature checking, spraying, cleaning, and delivering medical supplies and goods that are helpful in dealing with COVID-19.
Agam Bansal[56]	2020	• Propose a framework to deal with falsification of data and people seeking out COVID-19 infection, challenges while using immunity certificates using blockchain technology. • An immunity certificate is a document to certify a person has been infected and is

		immune to COVID-19.
Priyanka Haleja[57]	2021	• Study research gap in healthcare privacy and blockchain technology. • Shows the doctor-patient treatment interaction using a private platform namely, Corda. • The project is named I Treat You.
Daniel-Jesus Munoz[58]	2019	• Develop a model called ClinicAppChain a decentralized healthcare ledger. • Through which patients can decide what data they want to share, and with whom, with a minimum cost that consumes negligible energy. • Platforms take care of authentication, privacy, and permissioned data sharing.
Junho Moon[59]	2020	• Propose a health data management system using a distributed ledger. • Personal users can be participants of the systems, and they can manage and store their information on the platform that solves legal issues that can be arisen. • Improve data utilization. • There is future research to the proposed system, standardization of health data.
Atul Garg[60]	2020	• Evaluates and Compares seven commercially COVID-19 testing kits for pooled sample testing. • The sample was taken of 40 positive and 10 negative cases. • All kits performed well, but four kits

		performed more accurately they are recommendable for more use.
Shinji Kawakura[61]	2019	• Develop a system for traditional agriculture using the Corda platform. • The study consist of three stages:- i) Designing and validating the entire system. ii) Construct and modulate numerous minor system settings. iii) Conduct experiments.
Marko Kompara[62]	2018	• Studies the usage of blockchain in the healthcare industry. • Proper analysis of the result is discussed. • Consider the study of 33 publications using a predefined methodology. • Various applications discussed like data sharing, access control and health records.
Jens Mattke[63]	2019	• Studies the insights of the MediLedger blockchain platform for the pharmaceutical supply chain. • Provide challenges and solutions for further work. • Recommended Solutions can be listed as:- ▪ Use a "benevolent dictator" and base administration on "consensus through joint effort". ▪ Save the verification of transactions, not simply the transaction, on the blockchain. ▪ Use zero-information proofs to check product and transaction authenticity while protecting full privacy.

		▪ Use blockchain application capacities not found in traditional technologies to fix incapable IS landscapes.
Victor Clincy[64]	2019	• For choosing the best platforms for development, provide a comparative study of different blockchain development platforms. • Compares five platforms namely, Ethereum, R3 Corda, VeChain Thor, HyperLedger Fabric, and Ripple.
Christian Cachin[65]	2017	• Discusses the method of gaining and assessing confidence in the resilience of the consensus protocols exposed to adversarial and fault nodes. • Review consensus protocol in permissioned blockchain platform considering resilience against attacks. • The protocol comparison covers Ripple, Tendermint, R3 Corda, Chain, Stellar, IOTA, HyperLedger Fabric, Kadena, Quorum, Sawtooth Lake, MultiChain, Iroha, and Symbiont.

CHAPTER 3

Blockchain Validation Framework for COVID-19 Testing Kit

3.1 INTRODUCTION

In recent years, blockchains have become increasingly popular. As the name suggests, a blockchain is a series of blocks that store data. A group of academics devised this method in 1991 to timestamp digital documents so that they could not be retroactively updated or changed. A notary public-like appearance is nearly there. Between then and 2009, it went mostly unnoticed until Satoshi Nakamoto included it in his proposal for a payment system based on distributed ledger technology.

It is possible for everyone to view a blockchain since it is a distributed ledger. Blockchains have an interesting feature that makes it very difficult to modify data once recorded on them. Because each block contains data, as well as its hash and the preceding block's hash, it is impossible to tamper with the idea of immutability.

Depending on the kind of blockchain, the data included inside a block may differ somewhat. When a transaction is completed, the blockchain keeps track of the sender, receiver, and the amount of currency involved. A block may also have a hash as a component. Heaps of digital fingerprints may be found in hashes. Like a fingerprint, it may be used to identify a block and all of its contents. After a block is formed, the hash of the block is computed. If anything in the block is modified, the hash will also be modified. To put it another way, hashes are critical for detecting block modifications. A block is no longer the same if its fingerprint changes.

The preceding block's hash is the third element in each block. When a chain of blocks is established using this method, it ensures the blockchain's security. A graphical representation of the chaining process, such as the one shown below, may be useful in improving your understanding.

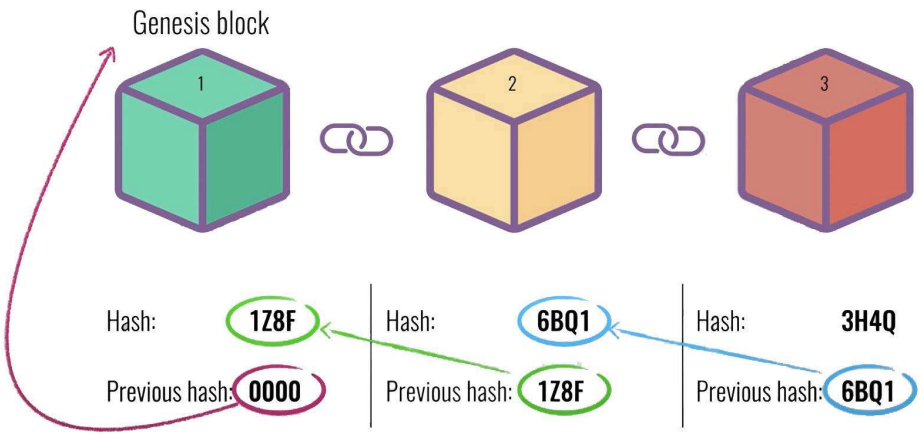

Figure 3.1: The first three blocks of a blockchain.

3.2 SECURITY IN BLOCKCHAIN

Here, we'll go over some of the most major blockchain security concerns, as well as address the question, "Is the blockchain truly secure?" So, taking both forms of blockchain into consideration, let's look at the security feature. Blockchain security is primarily defined by the kind of blockchain we are using, because each type has unique ramifications for participation and data access rights, and blockchain networks may be classed as either private or public depending on participation privileges. Public blockchain networks are available to the public and could enable any user to join while protecting participant anonymity. This form of blockchain mostly depends on computers linked to the internet to verify transactions and, on the other hand, reach consensus. For authenticating membership and access credentials, private blockchain networks depend on identification. They also permit only well-known firms to participate in the system. This understanding of the security issues connected with different forms of blockchain networks brings up new options for learning about blockchain security concerns. Furthermore, knowing which blockchain networks are best suited to a person's business goal could aid him in making superior privacy and security options. For example, private and permission networks may have stronger regulatory and compliance limitations, whereas public and permission-less networks may offer you with greater dispersion and decentralization. Before we dive into the

security problems, let's address the basic question of whether blockchain is actually secure. Because it will help us to have a more thorough knowledge of the situation. As we know, the description of blockchain technology stresses immutability and decentralization of cryptography, as well as the promise that no one can modify your data without the knowledge of other participants. Blockchain looks to be fairly secure, and it can surely give a tamper-proof record of transactions. However, this does not rule out the prospect of cyber-attacks and security breaches. People with malicious intent could take advantage of blockchain security holes, and various incidents of blockchain attacks have been reported in the media from time to time. These recent incidents may be utilized to illustrate some of the most worrying circumstances that highlighted the security hazard of blockchain.

1> *Code Exploitation*: This event highlighted privacy and security issues with the blockchain of the decentralised autonomous organisation, or DAO, where programmers were fixing a problem with code malfunctioning on the system while an unknown attacker began raining ethereum on the DAO, which was collected from the sale of its token. More than $60 million in ethereum was stolen in only a few hours, and the impact to DAO was substantial since it accounted for almost a third of the company's overall value. If we look carefully at this scenario, we can see that code exploitation was the major cause of the event, which clearly revealed the vulnerability of the blockchain infrastructure.

2> *Missing keys*: Cryptocurrencies have been stolen in the past. One such case came from a Hong Kong-based exchange. The quantity taken was close to 72 million dollars, and the most probable cause of the event was stolen private keys or personal digital signatures.

3> *Hacking employee system*: Another example of a blockchain security risk includes one of the biggest cryptocurrency exchanges in the world, which is based in South Korea. In this instance, hackers were able to access the data of around 30,000 individuals as well as steal cryptos worth 32 million dollars. Surprisingly, the core systems were not impacted, and the chief cause was a hacked staff desktop. As a consequence, we must acknowledge that if an attacker obtains access to a network node and internal security measures are neglected, it may be an expensive mistake for a corporation.

Analyzing the aforementioned assaults, we may conclude that the blockchain itself is secure because no proof of disruption has been found, but the peripherals that surround it are not. In other words, "*The locks guarding a safe-box are secure, but the keys to the lock are not safe*," especially from the standpoint of a rookie user. However, we can't exclude a couple of the additional public blockchain threats listed below.

1> *51% Attack:* In certain scenarios, such as 51 percent attacks, a public blockchain isn't as secure as it looks. A 51 percent attack happens when a group of miners gets control of more than half of the network's hash rate or processing power. If an attacker succeeds in taking control of the network, they will be able to block future transactions from getting confirmation, suspending payment between some or all network members. They will also be able to reverse transactions that were done while they were in charge. This suggests they may easily spend twice as much money. Furthermore, it is vital to recall that during the assault phase, an attacker will probably certainly not be able to issue new coins or modify earlier blocks, but you may argue that a 51 percent attack would almost definitely destroy public blockchains like bitcoin, even if it is resolved in time. If we want to prevent 51 percent attacks on blockchains, we need to put in place certain safeguards. For example, we may increase mining pool monitoring and make sure that proof-of-work consensus techniques don't allow for a larger hash rate.

2> *Routing Attacks***:** Routing attacks are another method that a blockchain may be disrupted, despite the fact that a blockchain node can be situated anywhere on the earth. The network's nodes are now distributed around the planet in a non-uniform way. Because all blockchain networks and applications depend on massive volumes of data being transferred in real time, this is a necessity. In this situation, all an attacker has to do is intercept data while it is being transferred to internet service providers. An attacker may, for example, deploy routing attacks to split the network into two or more different components, blocking nodes inside one component from connecting with nodes outside of it. The attacker causes other blockchains to be constructed. After the attack has concluded, any blocks detected inside the smaller component, as well as any transactions related with them, will be discharged. It has been discovered that the bulk of traffic transferred between bitcoin nodes passes

through just a few ISPs (Internet Service Providers). According to the statistics, 60 percent of all bitcoin connections cross three ISPs. In other words, three Internet service providers have access to 60 percent of the world's bitcoin traffic. Furthermore, the anonymity of routing attacks in blockchain security makes them problematic. Because everything appears normal on the user's end, blockchain participants are unable to identify the danger of routing attacks. Routing attacks are routinely used to leak sensitive data or extract monetary rewards while without disrupting network participants. As a consequence, it is obvious that routing attacks may be dangerous as they might inflict substantial damage before being recognized.

3> *Blockchain endpoint vulnerabilities***:** Endpoint vulnerabilities are essential because of the environment in which they occur, which in most circumstances is where humans and blockchains intersect. To put it another way, an endpoint may be anywhere. A person is obtaining access to any form of data, and most hackers are aware that guessing an end user's key is fruitless. They spend a lot of time trying to steal them, and the best method to obtain them is to attack the weakest link in the system, which is generally a computer or a mobile device. It's also worth mentioning that the process of contacting blockchain in order to obtain data is what makes endpoints so vulnerable. Harmful attackers have access to all endpoints and can exploit them to get harmful code in or out. The distinction is that some are tough to crack and others are not, but once a device has been hacked, hackers may exploit the credentials of high-level users to wreak the greatest damage to a network system.

4> *Vendor risks***:** Companies wanting to use third-party blockchain applications and platforms are usually ignorant of the security dangers associated with defective or exposed suppliers, and it is not uncommon for vendor solutions to put a low focus on security precautions in their system core code. Even personal faults that may enable unauthorised parties to examine their customers' blockchain credentials. This threat is particularly relevant when talking about products that leverage smart contracts. Since a smart contract on a blockchain may store an organization's whole functioning and rules. This sort of vulnerability has the potential to wreak a lot of harm.

5> *Transaction privacy leakage***:** Transactions on public blockchain networks are open and transparent, and the design of the network makes every transaction traceable. The publishing of this data on the network maintains the information synced and helps remote nodes to achieve consensus. However, there are potentially major privacy problems linked with the public data, since transactions in certain blockchain applications, such as internet of things or mobile, carry sensitive information about their difficulties. Privacy violations in crowdsourcing transactions could have major ramifications. The exposure of transaction content, meaning the study of transaction graphs, could show the link between separate transaction addresses, leading in indirect privacy leakage. This connection could lead to the discovery of a user's identity based on other data gathered elsewhere. The most typical solution to transaction leakage is to provide a mixing service, which, if active, enables several users to conduct transactions with diverse inputs and outputs at the same time, preventing the transaction inputs from mapping to their related outputs.

6> *Phishing attacks***:** Phishing is one of the most frequent luring methods deployed by hackers, as we all know. It's simply a phishing campaign to obtain a user's credentials. Hackers spoof authentic and authoritative sites to send emails to wallet key owners. These emails solicit information about user credentials through a bogus URL, and once hackers acquire these credentials and vital information, both the user and the blockchain network are exposed to additional attacks. In the year 2020, there were roughly 1,00,000 phishing attacks detected. The simplest technique to avert a phishing attack is to educate wallet owners and critical network stakeholders on anti-phishing countermeasures.

The following security study was carried out using a simple blockchain that we constructed in figure 3.1. Assume that the second block, as illustrated in figure 3.2, has been tampered with. The hash of the block is also changed as a result of this. As a result, block 3 and all subsequent blocks will be invalid since they will no longer retain a valid hash of the prior block. As a result, altering a single block invalidates all subsequent blocks.

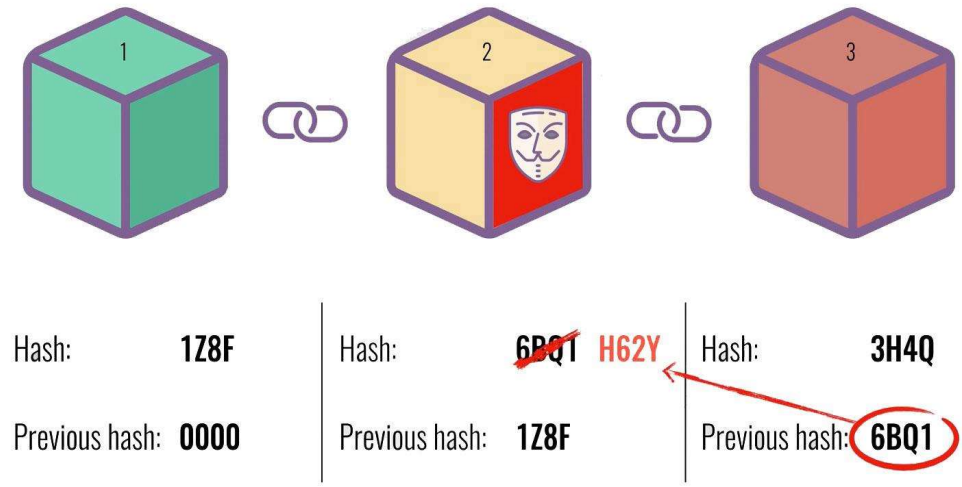

Figure 3.2: The second block being changed by the attacker.

However, hashes alone are inadequate to prevent tampering. These days, computers are exceedingly fast, capable of computing hundreds of thousands of hashes per second. To make our own blockchain legal again, we could easily tamper with a block and recalculate all the hashes of other blocks. As a consequence, blockchains contain a feature known as proof-of-work. It's a mechanism that makes the creation of new blocks take longer. The time it takes to compute the appropriate proof-of-work and add a new block to the chain is the process at action here. This strategy makes tampering with the blocks exceedingly difficult, since if you tamper with one block, you'll have to recalculate the proof-of-work for all following blocks.

As a consequence, a blockchain's security is derived from its novel use of hashing and the proof-of-work mechanism. But there's another way that blockchains keep themselves safe: they're distributed. Instead of depending on a central authority to maintain the chain, blockchains rely on a peer-to-peer network that everyone may join. Anyone who joins this network obtains a full copy of the blockchain. This may be utilized by the node to confirm that everything is still in functioning condition. Let's take a look at what happens when someone builds a new block. Everyone on the network gets the new block. The block is then confirmed by each node to verify that it hasn't been tampered with. Each node adds this block to their own blockchain if everything checks up. This network's nodes join together to produce a consensus. They

have achieved a consensus on which blocks are legitimate and which are not. Blocks that have been tampered with will be rejected by the network's other nodes.

To successfully tamper with a blockchain, you'll need to tamper with all of the chain's blocks, redo each block's proof-of-work, and obtain control of more than half of the peer-to-peer network. Only then will an attacker be able to add a tampered block that everyone else accepts. However, as any generation of processing power may anticipate, this is almost impossible.

As we can see, this is nearly difficult! Blockchains are likewise in a perpetual state of evolution. The invention of blockchain technology piqued the curiosity of many individuals. Others soon recognized that the technology might be used for a variety of purposes, including keeping medical information, creating a digital notary, and even collecting taxes, to name a few.

3.3 VALIDATING SUPPLY CHAIN MANAGEMENT (SCM) IN MEDICINE WORLD

Throughout history, epidemics and pandemics have sunk civilizations and brought powerful countries to their knees. Among the deadliest are Spanish flu, Swine flu, the West African Ebola pandemic, and the Zika virus outbreak. The 2017-18 influenza season was very harsh, with a high number of outpatient clinic visits and a large geographic spread. Few Machine Learning and Blockchain learning technologies have been applied to mitigate the dangers of this disease. Drug counterfeiting was recognized as a global concern in a research issued by the World Health Organization.

In the event of a pandemic, counterfeiting or falsification of critical drugs can result in the deaths of unaware members of the population. Counterfeit drugs pose a threat to individuals and the wider population. In this chapter, we look at anti-counterfeiting measures for critical pharmaceuticals utilising blockchain technology, which is a decentralized ledger that can be shared immutably and transparently. In a blockchain, the supply chain connects all of the key drug manufacturing businesses and guarantees that data reaches its intended receiver. The supply chain for medication manufacturing can start with the raw material supplier, who is responsible for supplying the raw ingredients needed to make the medicine, and end with the drug's final consumer. Many

researchers may establish their supply chains based on the priority of the stage of medication or vaccine development, depending on the substance and the number of stakeholders involved in the supply of that item.

To fulfill market needs, data must flow in both ways to and from suppliers, manufacturers, distributors, retailers, and end users for supply chain management to operate. It includes both market demand for commodities and supply of goods at various levels of supply chain management. According to conventional pharmaceutical supply chain management, raw material providers offer raw material to manufacturers for medicine synthesis, packaging, and distribution. Medicine inventories are also within the producer's control. This is the beginning of the medication distribution process. Distributors supply the drug to hospitals, merchants, and pharmacies in the second step of pharmaceutical distribution, based on the needs obtained from patients.

The approved FDA manages the historical pharmaceutical supply chain management procedure. The product tracing standards and compliance policies are described in the Drug Supply Chain Security Act of 2013 (DSCSA) [2]. It aids in the identification of pharmaceuticals as well as giving "tracing and tracking" capabilities in order to prevent counterfeit drug use. In this case, each medicine container must be tagged with a unique identity. The medicine package was then sent from the manufacturer to the distributor, then from the distributor to the retailers for subsequent identification. A pharmaceutical drug's supply chain may be monitored with the use of a unique identifying number (Bar code). In 2015, counterfeit pharmaceuticals were marketed globally for between $163 billion and $217 billion, according to a PwC estimate [3]. Drug tracking in the supply chain is extremely challenging.

According to PwC [4,] blockchain can aid in the tracking of pharmaceutical supplies. Furthermore, it can assist in evaluating the package and identifying quality compromises, ensuring that low-grade drugs do not reach end consumers. The legacy supply chain management frameworks are lacking in offering trust among the participants due to a nontransparent process among suppliers, carriers, manufacturers, distributors and retailers. It includes only paper agreements between suppliers to the carrier and carrier to manufacturer [5]. In such frameworks, it is difficult to trace the breach of contract. In addition, it is required to achieve demand forecasting (Uncertainty demand of an epidemic breakout) for better preparedness to avoid any drug crisis,

information visibility about logistics and quality management, managing perishable product through proper inventory management and timely supply of drugs, real time tracking and tracing, maintaining temperature control and drug counterfeiting. To address, above problems in pharmaceutical supply chain management, a blockchain/distributed ledger technology based information management with the required smart contracts can be considered. Many other blockchains have been popularized with different consensus mechanisms. Blockchain has grown for various applications in public and private sectors all over the world.

3.4 BLOCKCHAIN VALIDATION FRAMEWORK FOR COVID-19 TESTING KIT

Throughout the current pandemic situation, the functioning of the Covid-19 testing kits is very critical owing to its necessity in the diagnosis of the disease. The fabrication and supply of these kits is taking place at a large scale, therefore there may be some malpractices in the supply process. The authenticity of the kits is primarily significant and to keep the globe from using the defective kits is a big challenge. Therefore before using the kit, it must have been permitted by some authentic and authoritative medical body such as EUA, ICMR, CCMB, etc. So, the validation of these testing kits is vital for the fair conveyance from production houses to the various agencies.

COVID-19 disaster began from Wuhan, China in Nov'19. It was brought about by a coronavirus called SARS-CoV-2. It has been declared as a pandemic by WHO on 11'March'2020 and till 19'July'2020. This fatal disease causes 5,615,082 deaths across the world. The stats showing the number of deaths and the total number of cases that occur monthly is depicted in the fig1.1. During the Covid-19 catastrophe, testing kits are produced and distributed in enormous numbers to manage the pandemic quickly however it is highly unlikely to approve the validness of the result from these kits all around. In this pandemic, fast testing along with accurate results is needed. There are numerous validating parties who can authenticate the working of these kits. One of such approaches is Supply Chain Management (SCM) which is described in the scope of Blockchain to cope with COVID-19[2].

SCM tracks the record of benefits from a raw product to a completed one or from provider to the purchaser. To keep up the unchanging nature, transparency between all the procedures in SCM can be achieved with the assistance of Blockchain.

Blockchain is the technology behind the concept of Bitcoin which is the effort of Satoshi Nakamoto in 2009[1]. Blockchain is a decentralized, immutable database or chain of records or blocks where every block holds the set of transactions, it is a distributed shared ledger that brings transparency. This technology firstly implemented Bitcoin in 2014 as a cryptocurrency. It conquers different exchange matters as a double-spending problem, yet it isn't just constrained to the money related division as Blockchain catches the eye in different commercial enterprise sectors such as landed property, Education and Healthcare etc. get explored every day. In this paper, we implement the application of the pharmaceutical supply chain using Blockchain.

In order to ensure a safe or efficient supply chain for COVID-19 test kits, similar types of structures have been developed used in the pharmaceutical supply chain and other healthcare-related areas such as MedRec, ModelChain, MediLedger, etc. To develop these systems, many researchers have used various platforms such as Ethereum and Hyperledger Fabric to achieve transparency. All mentioned in comparison to R3 Corda, the platforms employed are not sufficiently protected and unable to provide privacy. Corda is a cryptocurrency that runs on a private Blockchain technology that runs on Java and Kotlin and is mostly used in the banking sector. The technique is not exposed to the user The current supply chain model for Covid-19 testing kits is as follows and there is a risk that manually maintained records of kit validation will be lost. The kit is sent to an authorized a celebration for validation; the validating party simply saves management of the supply chain. There's a danger that consumers won't be able to get accurate data about kit validity. This prompted the development of a Blockchain platform for pharmaceutical management of the supply chain .The following are the contributions to the SCM proposed COVID-19 testing kit framework. Our framework is very secure, ensuring that no unauthorized parties or nodes are incorporated into the chain, as well as great transparency. Each transaction is checked by a Notary, ensuring that no duplicate or inaccurate transactions are added to the chain. The mistakes may be proven to the consumer through punching the Serial Number if the package isn't always

validated. So, our framework is greater green than the present technique utilized in trying out package deliver chain management.

To the nice of author's expertise and belief, this framework may be applied in real-global software and might update the existing approach.

3.5 BACKGROUND WORK

3.5.1 Blockchain

Blockchain is a decentralized technology in this several nodes or system contributes to the common ledger which stores unchallengeable records or sets of the transactions that are safeguarded via cryptographic capacity or extraordinarily statistical numerical complexities. This function utilise of the form [8] which can be demonstrated by the equation 1.

$$H: K \times M \rightarrow \{0, 1\}^{n} \quad (1)$$

Where H represents hash and

n represents the number of bits returned through the function.

A local copy of the ledger is saved on every node that creates transparency i.e. if any modification is done to the record or new exchange is completed then all nodes will update their local ledger appropriately. The architecture of blockchain may be shown in figure 3.3.

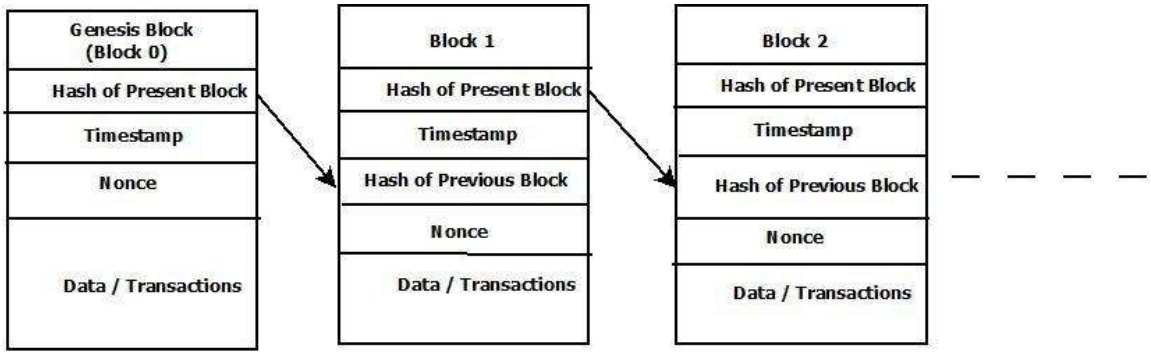

Figure 3.3: Architecture of Blockchain

Blockchain technology has fault-tolerance i.e. if any node fails then there would be no effect on other nodes. This technology is very guarded and no other technology can surpass it in terms of transparency. Blockchain is the main choice to provide 21st century cyber-security, and until now there is no rift created in it that makes its excellent option to use in the sector of Healthcare and SCM, and good to utilise in the pandemic like COVID-19. With the aid of blockchain, anybody may trade digital assets where they don't have to depend on any third party or to trust each other and exchange the asset under the contract called smart contract which was invented by Nick Szabo in early 1990s[9]. A smart contract is a piece of code or agreement on which trade partners accede to particular terms and conditions. Every time, ownership of an asset changes then the new transaction will save to the blockchain by default, and to confirm the accuracy of the transaction, the process of mining is conducted by the group of individuals or nodes called miners then they gain incentives correspondingly. Miners verify the transaction by employing a consensus method to determine whether a block of the transaction should be put in the Blockchain or not. There are two sorts of consensus methods employed termed proof-based and voting-based. In proof-based consensus techniques, nodes solve the cryptographic hash function to achieve an agreement to determine the current state of a distributed ledger. The first proof-based consensus method dubbed Proof-of-Work (PoW) was proposed by Satoshi Nakamoto. Some of the other proof-based algorithms include Proof-of-Stake (PoS), Proof-of-Elapsed-Time (PoET), Proof-of-Luck (PoL), Proof-of-Space [10]. In a vote-based consensus method, the voting strategy is employed in which a threshold value is specified, let say 'y' then minimum 'y' participating nodes should agree on the decision that block should be placed in the blockchain or not. Some of the voting-based consensus techniques are Byzantine and Crash. In market, n number of blockchain platform is accessible but we may categorize in certain particular ways such as public, private, hybrid and consortium Blockchain. In a public Blockchain, anybody may quit or join the network and everyone can participate in the decision of the current state of the system or what block should be added, Ethereum [11] and Bitcoin are some renowned public Blockchain. The private Blockchain is regulated by an organization and grants rights to all others; Hyperledger Fabric [12] and R3 Corda are some prominent private Blockchain. In consortium Blockchain, the Blockchain is governed

by certain pre-selected nodes and privileges provided to all other nodes may be limited, Quorum and Hyperledger is some consortium Blockchain. In the Hybrid Blockchain, the blockchain includes of aspects of both centralized and decentralized computing e.g. Dragon chain [13].

In this research, we employ R3 Corda to construct the suggested system since it is a permissive, private platform, and multiple consensus or self-developing algorithms may be used that are selected by the notary. We cannot utilize Ethereum, since it is a public platform that is not secure as much as R3 Corda.

3.5.2 R3 Corda

The Corda largely directed to financial sector and it hold up smart contract and this is the decentralized system [15]. In this Corda, Have excellent capability of smart contract which are accountable for acceptance or deny the transactions. This is individual Blockchain which restricts users to delete or add, if any node transfers data to another node then data is only viewable among those two nodes but on other platforms, we can see every node data. The building block of Corda is a "state object" that represents a particular instance of specific agreement reflecting a piece of contract or real-world contract. The data is safeguarded in Corda by utilizing the SHA-256 hashing technique. To achieve globally distributed consensus Corda offers three major tools and they may be characterized as below:

- Smart contract logic which appraises constraints to check valid or not using set of rules.
- Notary pools that implement uniqueness and timestamping services.
- Flow framework that reduces the process of writing complex multistep protocols.

With the use of transactions, updates are done in which Corda inputs current states' objects and outputs new state objects. There are two primary characteristics of consensus [14]: -

- Transaction Validity
- Transaction Uniqueness

In Corda, the transaction may be constructed at any moment and by anybody since there is no requirement for crypto-economic. Unlike Bitcoin and Ethereum, Corda does not utilise miners or proof-of-work since it does not arrange transactions using a blockchain. Instead each state point to a notary that assures it will accept the transaction if all the input states are un-consumed. Transactions are defined in Corda with the aid of JVM it implies class file execution entirely deterministic. The applications produced or operated on the Corda platform are termed CorDapps (Corda Distributed Applications). CorDapps is the collection of JAR files containing class definitions that are programmed in Java and/or Kotlin. A class description has various components named Flows, States, contracts, Services, and Serialization White lists.

3.5.3 COVID-19 Testing Kit

As a significant public health danger, the COVID-19 pandemic can only be contained by more thorough testing, which will allow for greater understanding of the virus's transmission and breadth of spread. Currently, there are two types of testing available for COVID-19[16], namely, viral testing and antibody testing. When a virus is tested, it may identify a current infection; however, antibody testing can disclose a former infection and may be unable to detect a current infection since the body takes 1-3 weeks to produce antibodies to fight against contamination. On the rare chance that any of the signs and symptoms of COVID-19 infection are seen in someone, they may be subjected to viral testing. The symptoms of COVID-19 infection include dry cough, fever, and weakness. However, even if the results are positive, it does not necessarily mean that you are not infected; it is possible that at the time of testing, early samples were collected and the results were negative, in which case protective measures must be followed in both cases. In both cases, protective measures must be followed. The viral test determines whether or not SARS-Cov-2 nucleic acid or antigen, which produces COVID-19, is present in a patient's respiratory system by taking samples from the respiratory system.

There are various methods available for COVID-19 testing [17]:

- Reverse transcription-polymerase chain reaction (RT-PCR): - Due to the fact that it employed reverse transcription to get DNA and then PCR to amplify DNA, it was able to identify SARS-Cov-2, which is exclusively composed of

RNA. The results of RT-PCR are available in a matter of hours. It offers a number of benefits, including dependability, high throughput, and automated operation.

- Isothermal amplification assays: - It increases the size of the virus's genome. Because it does not need repetitive heating and cooling, this process is much quicker than PCR. In contrast to RT-PCR, this approach does not need an extra step of RNA to DNA conversion since it amplifies RNA directly rather than amplifying DNA.
- Antigen: - It looks for antigen proteins on the viral surface, which it calls antigens. Even while positive antigen-based test findings are quite reliable, there is a small probability of receiving a false-negative result. As a consequence, in the event of a negative result, the samples are analysed once again using PCR technology.
- Serology: - It is possible to identify once-infected persons who have been healed using blood testing; however, the time of when people are examined must be considered. The efficacy and defensive reach of anti-SARS-CoV-2 antibodies remain unknown. The possible role of antibody testing in determining whether or not a person is immune to COVID-19 is unclear, and the ability to detect SARS-COV-2 antibodies in persons recovering from an infection, asymptomatic humans, and those who had mild symptoms calls for additional investigation.

The testing kits are produced at a rapid pace and are an excellent tool for dealing with the COVID-19 outbreak. [18] The following are the components of a rapid IgM/IgG testing kit:Test cassette

- Droppers
- Package Inserts
- Buffer Bottle

While the kits should be stored at room temperature or frozen (2-30^{o} C), and the test cassette should be kept unopened in the conserved bag until no longer needed, the kit may be used to collect samples of serum, plasma, or blood. The following processes should be followed in order to finish the examination:-

- Collect the samples and make necessary preparations such as keeping the kit at room temperature before the test.
- By using micropipette/dropper add sample to the sample well.
- Add 1 drop of serum/plasma or 3 drops of blood to the sample well immediately.
- Lastly, stay for the indications to shown and examine the outcome at ten minutes because the outcome is valid only for 20 minutes.

In the literature survey portion of the background work, very little work has been done in the healthcare supply chain. Hence, developing a Blockchain-based COVID-19 is a problem that requires a solution.

Ijazul Haq[3] illustrates how medicine supply traceability may be done using Blockchain in the pharmaceutical sector. In the paper, he explores permission Blockchain and gives an example of how a system might be used by a nurse, a doctor, or a patient, among other parties.

Sandip Jangir [4] proposes a distributed ledger and smart contract-based architecture for medication supply chain management. The Ethereum platform was used to create this system, which provides anonymity, real-time drug traceability, and demand-supply management. For proof of concept of the suggested framework, extensive analysis and testing results in the form of Consumer Privacy, Information Transparency, Immutability, High Availability, Non-repudiation, No Single Point of Failure, and real-time drug monitoring were taken.

ModelChain, a tool developed by Tsung-Ting Kuo[5], combines Machine Learning with private Blockchain networks to safeguard healthcare data. He has developed a new proof-of-information approach for assessing the Blockchain-based networked subset of artificial intelligence. Si Chen [6] presented a Blockchain-based supply chain excellence management structure that may be implemented in the actual world and can serve as a hypothetical framework for applying management to the scheme intelligently.

Mohamed Torky[7] proposes a unique technique to dealing with COVID-19 that use Blockchain technology to identify unknown COVID-19 infected instances. The framework's four main components are a P2P transportable application, an Infectivity Verifier Structure, a Blockchain Framework, and a Mass-Surveillance Structure.

3.6 PROPOSED FRAMEWORK AND METHODLOGIES USED

3.6.1 Implementation

A node may include a variety of classes and perform a variety of duties, as seen by the validator node in figure 3.4, which is an example of a validator node. The Node sends the request via the API programme in the form of an HTTP protocol request, and the API programmer then calls the flow to begin processing the request. To update the ledger, the flow start specifies different logics or procedures, such as updating the COVID kit detail. Following the call, the first steps will be done, which will include the creation of a transaction and the signing of the transaction using their secret keys. Afterwards, the transaction will be sent to the counterparty, or opposing party, between whom the transaction is taking place, in our instance, this is signified by the word Manufacturer. He will examine the transaction and determine whether or not the transaction has been notarized by a notary public. If everything is in working order, the transaction will be saved and sent to the vault, after which it will be returned to the API and an HTTP response will be created. All of the operations will be the same for the Manufacturer node, and everything will be protected by the SHA-256 cryptographic hash algorithm. All information will be stored in an encrypted manner, and each node will have its own set of private and public keys to protect its data.

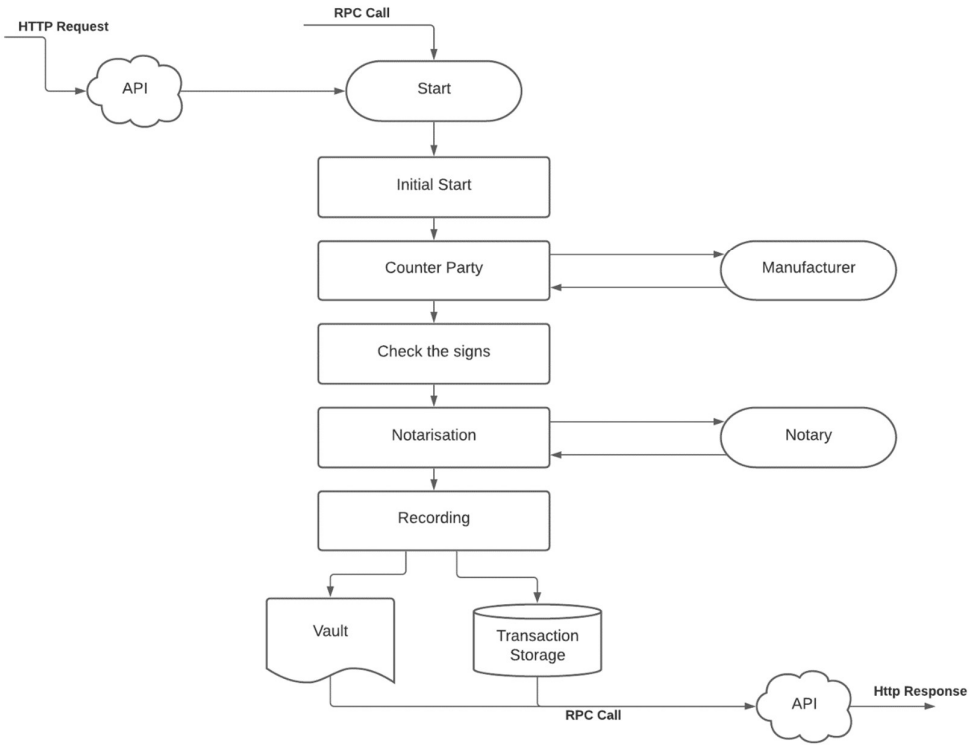

Figure 3.4: Architecture of Validating Node

3.6.2 Framework and Entities

Testing kits are playing an important part in the COVID-19 pandemic scenario, helping to speed testing as soon as possible and hoping to be made free of COVID-19. One of the most significant aspects of improving testing kits is having them officially checked, which is necessary for seamless testing operation. Before using testing kits, it is necessary to verify them via an authorized authority. In this scenario, accuracy and usefulness play a critical part in the overall effectiveness of the kit. A blockchain-based supply chain management system will be used to ensure that this is achieved. This is necessary because there is the possibility that the manufacturer will deliver testing kits directly to consumers, or that any fault will occur somewhere along the supply chain between the manufacturer and the consumer. The flow of control or data may be shown in figure 3.5 by the arrows.

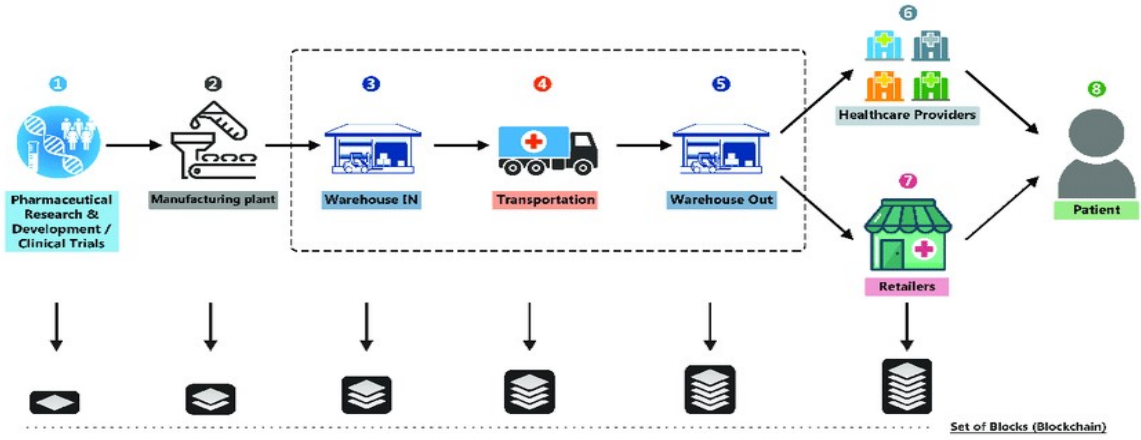

Figure 3.5: Data flow diagram of the proposed framework

The people involved in the complete procedure will be the following:-

Notary:-

In order to verify and validate any transaction or updating and checking the presence of any dependencies Corda platform have a network service known as notary.

Manufacturer:-

Keeping in mind the rules and regulations by various medical agencies the manufacturer built the testing kit, and send the kit for validation to any certified validating party, and then finally supply it to the customer. All the mandatory information required for the traceability will be furnished on the supply chain.

The details filled by the manufacturer can be shown below by an example:

{ "**nameOfKit**": "RT-PCR",
"**nameOfManufacture**": "India-MART",
"**manufacturingDate**": "2022-01-27",
"**expiryDate**": "2023-01-27",
"**kitInfo**": "OK" }

The next step after giving required details and a distinctive id, which can be a serial number will be created for future use.

Covid kit details are added with batch number **ff567009-af4c-1ed6-b5a9-e1131682e653**

Suppose the validating party rejects the testing kit then the manufacturer has to update details of the kit to the chain which can be shown below:

{"**serialNumber**": " ff567009-af4c-1ed6-b5a9-e1131682e653 ",
"**manufacturingDate**": "2022-01-27",
"**expiryDate**": "2023-01-27",
"**kitInfo**": "Updates by ICMR"}

Validating Party:-

ICMR can be considered as an authorized validating party. It is their responsibility to approve the further usage of the testing kit[19]. All the required standards are taken care while allowing the use of the testing kit. But if the testing kit is US-FDA attested no further approval is required. The validation of the kit is a standardized procedure involving lot of test reactions, methodology and reagents. These procedures led to the development of the validation report which is given to the manufacturer. Based on the report manufacturer performs necessary corrections otherwise supply it to its customer.
In order to maintain transparency the validating party (ICMR) uploads some of the information like serial number, comments, approval status and the details of the approver.

Kit produced which added to the chain will be sent to the validating party and update the details to the chain that can be shown below by an example. In the approval field, the party has to fill the value “Approved” or “Not Approved”. If the value is not approved then the kit cannot be supplied to the consumer, i.e. it is mandated for the manufacturer to again send the kit to the validating party for its approval after making necessary changes accordingly. The comment section/column includes the necessary changes that the party asked for.

{ "**serialNumber**": " ff567009-af4c-1ed6-b5a9-e1131682e653 ",
"**approval**": "Not Approved",
"**comments**": "Not Accurate",
"**approvedBy**": "ICMR" }

After the necessary changes made by the manufacturer, the validating party will

again evaluate the kit and carry out the various test. If the kit found satisfactory then the party have to update the details to the chain as per below mention an example:

{ "**serialNumber**": " ff567009-af4c-1ed6-b5a9-e1131682e653 ",
"**approval**": "Approved",
"**comments**": "Work properly",
"**approvedBy**": "ICMR" }

When the kit reached to the consumer side from manufacturer, the consumer can see the details like serial number, kit information, date of manufacturing as well as the date of expiration. This is viewed by punching the serial number. If no validation party is involved the consumer may get an error. The format of the error is given below.

{ "**status**":" No ",
"**message**": "Kit is not available with this Serial Number",
"**data**": "Not Found" }

If a kit is approved by the validating party then the user can see the details shown below:

{ "**status**": "OK",
"**message**" : " Kit is available with this Serial Number ",
"**data**" : {
"**nameOfKit**":"RT-PCR",
"**nameOfManufracture**":"India-MART",
"**manufacturingDate**":"Thu Jan 27 00:00:00 IST 2022",
"**expiryDate**":"Fri Jan 27 00:00:00 IST 2023",
"**approvedBy**": "ICMR" }}

The power of Blockchain lies in transparency; we can see all the phases of the testing kit. An example can be shown in the figure 3.6. From the figure, it is very much clear that how the rejection or approval of the testing kit takes place.

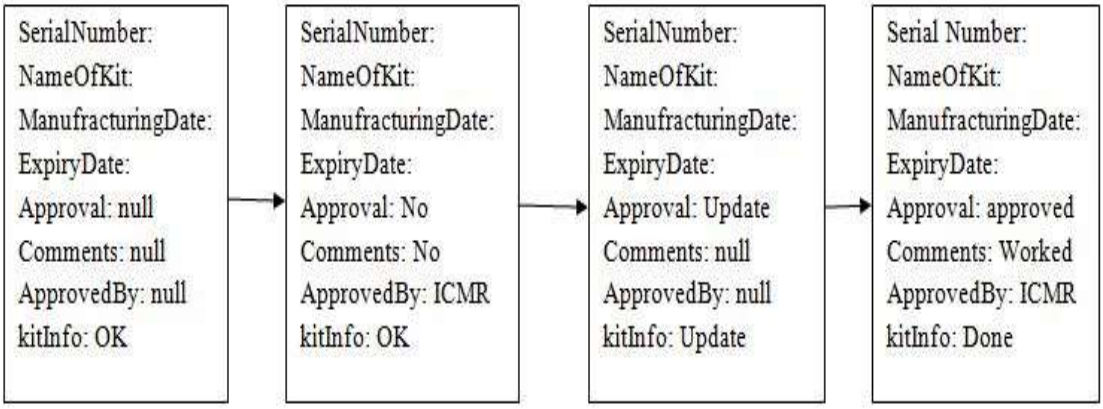

Figure 3.6: Supply Chain of Testing Kit

3.6.3 Tools Used

R3 Corda platform is used for the given framework, and the development is done through Cord applications [20].

- IntelliJ IDEA

  It is an IDE which facilitates development in most used languages like Kotlin, Java and required pulgins.
- JDK1.8

  Corda is a Java based application hence it requires JDK for development.
- Postman

  Postman is an API with responses for JSON and HTML and a compact layout [22].

3.6.4 Comparison of Ongoing Approach and Proposed Approach

The comparison is made between the traditional approach and new proposed framework on the basis of various parameters can be shown in the Table 3.1.

Table 3.1 Comparison between Approaches

Parameters	**Current Traditional Approach**	**Proposed Framework**
1. Methodology	Kit has to be validated before use.	Same
2. Transparency	×	✓
3. Security	×	✓
4. Hardware and software Requirement	Less	More
5. Immutability	×	✓
6. Cost Effective	More	Less

CHAPTER 4

Developed Model for analyzing perception of learner for digitized education during covid19 using machine learning

The emerging corona virus caused damage on academia all over the globe. This study intends to investigate learner perceptions world using the latest technological culture produced by a COVID-19 pandemic, notably, online learning which has become prevalent internationally and in India specifically. The study employed quantitative research method and a small sample size of Indian learners from the four categories of education in India: universities, technical institutes, colleges of higher education and schools, all of which were selected based on the participant's state of residence. In a pandemic duration, the respondents filled a questionnaire via Google Forms. Research shows that many higher education institutions across the country implemented virtual learning during the COVID-19 lockdown, and that many educators are dissatisfied with the programme and don't want it to continue after the pandemic because of poor network infrastructure and an insufficient supply. However, because of the pandemic, universities should encourage learners more interactively, not just through text but also through video, increase their online learning during in the pandemic so that they do not fall behind academically, and spend more time on e-learning until traditional learning resumes. Also, India's focus administrators should return to a traditional learning system as quickly as possible to combat the pandemic, as well as restructure the internet and electricity grid across the country. As a result, this study examines constructs hypothesized in the suggested hybrid model to gain a better understanding of the learners' perspective. A survey of 1439 pupils from an Indian university in the Lucknow area was used to obtain data. Random Forest and K-Nearest Neighbour Algorithms outperform other classifiers in terms of accuracy, according to data analysis and study findings. The outcomes of the study will aid in the development of learning applications that take into account students' perspectives on effective network technology.

4.1 INTRODUCTION

Corona infections are a diverse group of microorganisms that may cause a wide range of illnesses, from the common cold to more severe conditions like SARS and MERS. There are corona viruses that spread MERS and SARS. 2002 was the year SARS and MERS were identified in China, respectively. Virus SARS-COV-2 was identified in Wuhan and generates corona virus, the most contemporary virus to be discovered in Wuhan.

Wuhan, China, got its first report of a pneumonia of unknown origin on December 31, 2019, from the WHO Regional Office in China. Since then, the frequency of corona virus cases has increased, as has the mortality toll. In just 30 days, the Corona virus is transmitted from one location to the entire country. The World Health Organization designated it as COVID-19 on February 11th (WHO).

The COVID-19 virus forced several countries to shut down schools in March 2020, thus teachers had no option but to use virtual learning environments in their classrooms. It was a massive global incident. A critical incident, according to identity and teaching quality research, is an unrealistic expectation that obstructs the progress of the schedule and, by surpassing a certain emotional limit, tends to put the identity in jeopardy, forcing the teacher to reconsider their ideas, techniques, and feelings. When it comes to teaching and learning, these incidents may be valuable because they allow us to reassess our underlying ideas.

In order to help their students, many instructors were obliged to use digital technology for the first time because of the pandemic's widespread occurrence over the world. Schools in COVID-19 were shut down, resulting in dramatic educational reforms that had far-reaching consequences. Students' social and emotional well-being has deteriorated as much as their academic performance, as we've come to realise. In this climate, parents' involvement in their children's schooling has grown as well. The study's goals would not have been met without a re-examination of teaching methods in contemporary online classrooms. When instructors are incarcerated, they might utilise digital technology to reacquaint themselves with their methods and to re-evaluate one's knowledge of how to educate.

Most authors have suggested for decades that information and communication technologies (ICT) as educational equipment make it easier to tailor instruction to each

learner. Some claim that it's because they encourage cooperation, engagement, by use of multimedia coding, and the learner's ability to direct their own learning. In this approach, their inclusion in the syllabus would aid in the development of 21st-century skills (autonomy, cooperation, critical analysis, and problem-solving), which the OECD associates with the so-called "global competence" that should characterize modern education.

Since its inception, ICT has failed to fully realise its promise of revolutionising teaching and learning in schools. According to the PISA study results, many international studies' outcomes are really fairly discouraging. Students' literacy, mathematics, and scientific understanding have not improved noticeably in areas that have made significant investments in educational ICT, according to the OECD's assessment. As a consequence, it was found that the more ICT was utilised in the classroom, the less students learned about reading, mathematics, and science. In the wake of these results, the director of the PISA study and organiser Andreas Result said, "The fact appears to be that technology causes considerably more damage than help in our classrooms today."

In contrast to the bulk of experimental research looking at the influence of ICT on mobile learning, our results show the opposite effect. Even though we tried to perform an updated version of the same study ten years earlier, we found "a substantial positive medium to high effect size favouring the use of technology within the experimental setting over more traditional education (i.e. innovation) in the control group." Researchers have shown that touch screens in pre-schools, mobile phones, and computer games may have a modest but positive impact on students' educational outcomes. Teamwork and learning a foreign language are also important to them in college.

What is the source of this discrepancy between experimental laboratory research and large-scale studies? This disparity could be explained by a variety of variables. However, experimental investigations have been carefully structured and regulated to encourage the above-mentioned forms of learning, whereas classroom work is mediated either by activities of instructors who, across most cases, have so little ICT expertise. Several scholars argue that it is the instructors' use of ICT rather than the technology itself that can revolutionize the classroom and learning. While the practical studies

usually favour activities that enhance learner autonomy, most popular ICT uses, as evidenced by these worldwide studies with much more diverse samples, indicate alternative types of use where benefits are less certain.

Teachers' use of ICT in the classroom has been classified in a number of ways over the last few years. Using computers in education may be broken down into three categories: 1) basic computer abilities, 2) information-gathering tools, and 3) learning tools. Second-order digital skills connected to information systems and conversion into knowledge are enhanced by the last two applications away from the development of fundamental digital device abilities. Due to the fact that two types of usage are usually distinguished, the distinction is frequently made. Traditionally focused on information transmission and access, the first is referred to as "teacher-centered usage" (although some times it may be called for content-centered use). There are two types of 21st-century education: autonomous use and student-centered usage. Both foster a wide range of skills (autonomy, cooperation, critical analysis, logical argumentation, and problem solving). It is necessary to embrace a cognitivist theory of learning and to implement a student-centered strategy in which students control information using ICT rather than depending on instructors, as in the more traditional method.

According to the experimental results indicated above, student-centric techniques boost verbal earning, provide a better grasp of the subjects covered, encourage self-regulation of the training processes directly, and develop critical and collaborative views on knowledge. In order for students to benefit from computer-based teaching, it must be aimed at increasing students' awareness of ICT use and attempting to improve their navigation essential skills, constructing students' ability to differentiate between accurate and inaccurate material and access... and extract... and organise digital information," they conclude after analysing data from a variety of standard assessments. Additionally, they identified a little negative correlation between academic success and the use of ICT.

Despite the benefits of adopting student-centric uses, research show that the most common applications in classrooms are still oriented on teachers, who utilize ICT as a replacement for other more conventional means of communication. Even if the so-called type I barriers, such as the accessibility of these technological tools and the working environment in the centers, are overcome, several studies show that other types

II barriers, such as teaching and learning conceptions, limit the use of ICT to the large extend that those who facilitate the use of ICT.

Teachers' attitudes toward teaching and learning have been proven to be the most reliable indicators of how much time students would spend using technology in the classroom in many studies. Researchers have found that there are two types of views: those that are closer to a reproductive imagination of learning, which can be connected with teacher or content-centric education, and those that are closer to a constructivist vision, which favour student-centric teaching. Constructivist educators are more likely than more traditional educators to use technology in the classroom. Their approach is likewise more student-centered and emphasises the importance of problem solving. On the other hand, teachers who adhere to more traditional beliefs are more likely to utilise them to transfer information.

The link between concepts and teaching systems is not that apparent and direct. Many studies have found a misalignment between ideas and behaviours, particularly when it comes to constructivist beliefs which do not always correlate to productive or student-centric activities. There are 3 kinds of justifications that might be used to explain the discrepancies. To begin with, the beliefs appear to be more nuanced and less binary than previously supposed. Despite research shows that they are continuous of intermediate attitudes between both characteristics, investigations combining beliefs and practices usually focus on more extreme points of a spectrum-reproductive vs productive thoughts. Therefore, for example, so-called interpretative views, uphold conventional reproductive epistemological positions. These individuals believe that education is an exact statement of truth or the information that should be learnt, and that instruction is mediated by the learner's cognitive processes that are depending on user's behavior. Other evidence of this idea can be seen in Strauss and Shilony's 1994 technical-reproductive conception, which would be similar to a primitive information processing concept.

Secondly, we must recognize that neither instructors' ideas nor educational methods are constant, but rather change with the teaching setting. According to Ertmer, beliefs are multifaceted, but teachers adopt them in diverse degrees and with various forms of relationships. The teacher's views appear to be organized into profiles that combine

features of many teaching theories but whose activity is dependent on the circumstances.

Thirdly, we believe that because beliefs are complex, measuring or evaluating them is challenging, therefore different research may be examining different components. Many studies, for example, concentrate on explicitly beliefs, or "whatever teachers think to be true" in terms of learning, and so assess more broadly by how much ICT-based learning should entail. In most cases, these comments are more favorable to the benefits listed above. We selected to look at instructors' claimed practices in this paper as a way to address specific teaching ideas. Other factors that influence the usage of ICTs, in complement to beliefs, have been discovered, such as age, gender, level of education, and topic curricula, with mixed results. When Mathews & Guarino in 2000 reported that men were found more likely than women in using ICTs, no such disparities were identified in other investigations. Similarly, some studies found a negative association between both the age of instructors and its involvement in ICT, but some other investigations contradicted this conclusion. Furthermore, the experience teaching yields a mixed bag of results; some papers show a negative association, while others find none.

The impact of variables such as educational level and course subjects has even been investigated. The statistics appear to be even more convincing in terms of educational level: secondary school teachers have more positive opinions about ICT than teachers at lower levels. The data on the impact of subjects in the curriculum, on the other hand, is less conclusive.

While it will take some time to fully comprehend what has occurred in the classroom over the last several months, numerous research and proposals have examined its applications of ICT in distance learning. There are three categories of study that we may categories. The first sort of analysis looked at how classroom closures affected students' education, with many concentrating on their impacts on inequality or how other countries dealt with the crisis. Second, studies have been conducted with the goal of offering principles to guide and use of ICT in teaching and learning. The latter ones, which are relevant to the study's objectives, are concerned with how instructors were using ICT to address the COVID-19 dilemma. In several of these research, qualitative case investigations were conducted in various situations, institutions, and even nations.

Others, on the other hand, have used bigger samples of assessments to query about instruction in limited education. According to this research, the most prevalent use by teachers was uploading materials to a platform; the majority of activities were teacher-centered; and the more innovative the instructors are, more the use of ICT for limited education is recorded.

Despite these hints, no research has been done on the activities and applications of ICT in educational institutes during imprisonment. What kind of learning has been prioritized by teachers during this time? Is it more focused on verbal, procedural, or attitude-based learning? What actions, either more productive or generative, have encouraged these learnings? Have you employed ICT to assess the buildup of data or the worldwide capabilities required for its management? What factors influence whether you engage in one activity or another? These are some of the questions that drove our studies and are represented in the specific aims listed below.

1. Determining the frequencies with which Indian primary school teachers, as well as mandatory and non-mandatory secondary educational instructors, used ICT to carry out activities during the epidemic, and how various factors influence this occurrence (teaching experience, gender, educational level, previous ICT use, and curriculum subjects).
2. Examining the types of learning that these teachers most usually support (productive or teacher-centric vs. productive or student-centric), as well as the impact of the variables indicated.
3. Examining the sorts of results (verbal, procedural, or cognitive education), assessment, and social organization facilitated by ICT, as well as the potential influence of the variables indicated.
4. Determining whether different teaching profiles may be recognized in the use of ICT and their link to the factors evaluated.

It is hard to manage a specific hypothesis in respect to objective 1, as the inconsistent results discussed in the Introduction demonstrated. However, as stated in the beginning, we expect to find a larger frequency of generative (or teacher-centered) events than productive work in the context of objective 2. (student-centered). In a similar vein, for

the study objectives, we hope to locate more activities centered on speech perception, generative assessment, and individual task management, with few activities centered on student interaction. Finally, we expect to uncover teacher characteristics that vary in the quantity and types of tasks they suggest to their pupils, and that these characteristics are connected to a few of the demographic factors investigated in the study.

4.2 Research Questions

Some research questionnaires have been established in order to meet the thesis's objectives:

1. **Which machine learning model may be used to forecast whether or not students will adopt mobile-based learning?**

   For the purpose of determining which machine learning algorithms are most suited for the given data, the research topic aims to undertake a combined literature study and experiment.

2. **What characteristics will have an impact on the prediction outcome of mobile-based learning in students?**

   The goal of this study is to carry out an experiment in order to discover the characteristics that will influence the outcomes of mobile-based learning in students.

4.3 E-Learning

Remote learning is a process that takes place in a wireless classroom using Internet-enabled mobile devices to allow students to study, think, and collaborate from anywhere and at any time. Laptops, tablets, and mobile phones or wireless gadgets are among examples. Researchers have defined the word "mobile learning" in a variety of ways, including: -

The terminology used to define it are remote learning, a subtype of E-learning, and virtual classrooms using digital devices. Mobile learning is referred to as teaching and learning, Mobile-learning, Wireless learning, U-learning, Advancement of e-learning, while mobile, transportable learning, and personalized learning.

4.4 Wireless Applications / Appliances

Because of the current technology and trends, these mobile devices are becoming increasingly important around the world. In today's world, the types of mobile devices utilized in e - learning can be classified as follows: -

Laptops:

Laptops and notepads are examples of portable electronics that are commonly used in everyday life by all people in society. These machines use a number of wireless techniques to let users receive information, namely USB cables, Bluetooth, wireless connections, and some other infrared gadgets.

Desktop:

It's a laptop-sized device that's larger than a cell phone but less than a notebook. It can be used for a variety of purposes, including watching presentations, sharing photos, and video conferencing.

Smart Phone/Cell Phone:

It is a telecommunication device that performs additional functions than a desktop computer. It provides us with a high-resolution screen, a camera, a flexible Smartphone, and a variety of streaming systems and tools.

Other Movable devices:

Devices such as the Xbox, media players, joysticks, online media transmitters, gaming systems, and streaming video fall under this category.

4.5 Knowledge Discovery in Databases

The total step of discovering valuable information from data is described by knowledge discovery in database process (KDD). Despite the fact that there are different descriptions of the KDD Process model, the most of these agree on the key components. The KDD is defined by Fayyad et al. as an engaging and recursive. They lay out nine major steps:

1. Decide what you want to accomplish with the process and acquire whatever past information you have about that particular industry.
2. A suitable dataset from which to draw conclusions.
3. Data should be preprocessed. This includes deleting noise and potentially hazardous data records, as well as deciding on particular settings, including how missing feature values in the data collection are handled.
4. Delete variables or parameters that aren't important to the task's purpose in order to make the data more useable.
5. Agree on a data mining strategy for the KDD process's declared goal.
6. The next stage is to choose a data mining algorithm once deciding on a broad data mining method. It's vital to remember that this decision is frequently influenced by the end user's preferences, such as whether a comprehensible format or the highest level of predictive quality is preferred.
7. This is the most important step in the data mining process. The algorithm is then applied to the precompiled data collection. The programmee then explores the data for useful information.
8. Interpret the patterns discovered by the algorithm and, if necessary, return to a few of the previous phases to re-set the KDD process.
9. The final phase in database knowledge discovery is to use the processed results for other purposes, such as conducting additional study or implementing a technique to a real-world problem.

The KDD procedure, as indicated in step 8, might have a lot of iterations and loops. For example, after evaluating the results of such an approach, one can determine that the chosen method was a bad decision and return to step 5, or that the pre-processing was done incorrectly and return to step 3 after data reduction to a computable format in step 4.

4.6 Data Mining

KDD and "data mining" are widely used as synonyms in the industry. When it comes to KDD, data mining is a stage in which the right technique and algorithm are applied to the data collection. As a consequence, it plays a vital role in the process of discovering database knowledge. It is a data mining method that involves analysing any form of data and using various algorithms in order to discover patterns or structures within the data set before utilising these patterns or structures to categorise the data into different categories (labels). Scientific areas addressed include database systems, statistics, and pattern recognition. Algorithms classify data mining operations based on their comprehension of the data set's pre-existing classes:

4.7 Machine Learning

Pattern recognition generated Machine Learning, a branch of AI that structures data for easy interpretation by the end user. Many sectors, including finance, healthcare, military equipment, and space exploration, have lately used machine learning. Currently, the discipline of machine learning is seeing rapid growth and development. Programming computers with data improves their performance. In order to optimise a computer programme, it uses training data or prior experiences. It is also capable of making predictions about the future based on historical data. Mathematical models may also be developed using machine learning techniques. Human-free machine learning is the ultimate aim of machine learning, which is to learn from training datasets (experience) and create the desired output by looking for patterns/trends in data. This is what machine learning is truly good at. As you can see, it's broken down into four categories:

- Supervised Machine Learning
- Unsupervised Machine Learning
- Semi-Supervised Machine Learning
- Reinforcement Machine Learning

4.7.1 Supervised Machine Learning Technique

A supervised learning model is simply a machine learning-based model that is meant to predict. Classification/regression models may be trained using an annotated dataset and predetermined answers. Making predictions is made possible by the use of methods such as classification and regression.

Classification is used to anticipate discrete responses. For each instance, the algorithm assigns a class label. This kind of classification is called binary classification if it's done between two classes, and multi-class classification if it's done between more than two. Some examples of categorization applications include handwriting recognition, medical imaging, and others.

Continuous responses are predicted through **regression**. The algorithms return a statistical value in this case. As example, a collection of data is gathered to show that people are quite happy when the hours of rest is taken into account. Both sleep and happiness are factors in this equation. The analysis is now carried out by creating predictions. The following are examples of popular regression techniques:

- Linear Regression
- Logical Regression

4.7.2 Unsupervised Machine Learning Technique

Because we are not using supervised learning methods, there is no one to act as a guide or check our work. Patterns that show more often than others are what we're looking for. Density estimation is the statistical term for it. It is possible to measure density by clustering. As a result of this phase, the given data has been categorised into clusters. To find clusters that closely fit a categorization, the assumptions are made in this example. Data-driven methods like this one operate best when there is a lot of it accessible. As an example, depending on a user's recently watched movie list, Netflix recommends movies based on the "clustering of movies" idea. It mainly seeks for patterns in data that are otherwise undetectable, although the resulting estimates tend to be weaker than those obtained by supervised learning.

4.7.3 Semi-Supervised Machine Learning Technique

The phrase "semi-supervised learning" refers to information that is utilised in a manner that is somewhere in between supervised and unsupervised learning. Unlabeled and classified input are equally useful to semi-supervised algorithms. More accurate results may be achieved by using semi-supervised machine learning, which requires less explanation. To improve classifiers, semi-supervised machine learning technique uses largely unlabeled data supplemented with tagged data. Humans have much less work to accomplish here because less annotation labor is sufficient to provide acceptable accuracy.

4.7.4 Reinforcement Machine Learning Technique

Reinforcement learning is a type of machine learning that learns from trial and error in a dynamic world. The issue is fixed in this case by taking the required action in a specific setting in order to maximize production and attain the desired results. There is a display of the input or output information in Reinforcement Learning. Instead, when the agent selects the desired action, the person is quickly informed of the reward, and the following state does not take long-term actions into account. The agent must actively know about states, rewards, transitions, and actions in order to function optimally. The model is composed of the following elements:

- a discrete set of environment states, S;
- a discrete set of agent actions, A;
- a set of scalar reinforcement signals; typically {0;1} or the real numbers.

Furthermore, machine learning models are usually classed according to their underlying learning techniques, which are generally determined by the number of inference that the computer programme can accomplish.

- All classic computer programmes employ a process known as **role learning**. They do not make any inferences, and all of their knowledge must be applied

directly by the programmer because the application is unable to make a judgement or modifications from the data provided.

- All computer programmes that can convert information from a particular input language to that of an interior language are classified as **learning from instruction**. Despite the fact that the programmer still has the knowledge of how to conduct this transformation successfully, the computer programme must make certain inferences. As a result, this distinguishes a higher degree of learning from rote learning.

- **Learning by Analogy**, in opposition to Learning through Instruction, aims to acquire new skillset that are nearly identical to skillset and so simple to learn by transforming preexisting data. The ability to create mutations and pairings of dynamic knowledge skillset is required for this system. It adds new features that the original computer programme didn't have, necessitating a great deal of inference.

- **Learning from Examples** has become one of the most often utilised learning methodologies because it allows computer systems to build previously unknown skills or discover previously unknown structures and characteristics of the data. Learning by instances is a technique for predicting the target class of current data entries depending on a dynamic collection of predefined instances that is commonly used during classification and data gathering jobs. The proposed research problems will be addressed in this paper using techniques and algorithms from this area.

4.7.5 Decision Tree

If someone is looking for an easy-to-use way to study, the Decision Tree is one of the best options. An attribute that categorises the data input is one of the characteristic properties used by Decision Trees, which are made up of a collection of classification characteristics. An property that separates the data as much as possible is used to iteratively separate the data into the many current classes until a stop criteria is reached.

A tree-structured depiction of Decision Trees helps consumers to get a quick overview of the information, making it easier for them to comprehend the details.

Iterative optimiser 3 (ID3) and its sequel, C4.5, were developed by Ross Quinlan and were among the initial algorithms for Decision Tree training in 1986 and 1993, respectively. Based on these algorithms, a number of further advancements were made. The purpose of a decision tree is to help the user through the decision-making process. Decision rules are shown, as is the sequence in which decisions are made.

The three kinds of nodes in Decision Trees are the root node, the end nodes, and the inner nodes, also known as leafs. Decision support begins with no incoming edges at the root node, which signifies that the process has begun. The inner nodes always have a single incoming edge and at least two outgoing edges. An investigation of a specific characteristic of the data set is included. Among the questions that may be asked in such a test is, "Is the buyer above the age of 35?" There is a class prediction in each of the leaf nodes that provides the solution to the issue of choosing. If a consumer is asked whether or not they plan to purchase a product from an online store, and the answer is yes or no, this might be considered a choice difficulty. Leaf nodes have just one entering edge and no outgoing edges. The edges indicate the preceding node's decision.

Nodes that are separated from n by exactly one edge are referred to as children of n, but nodes that are not separated from n by exactly one edge are referred to as the parent of all their children. Below is a picture of a decision tree. Example: When the temperature property "cold" is sent down to the left sub-tree, a data record tagged "North Pole" with the characteristics "chilly" would have been sent down to the leaf "North Pole."

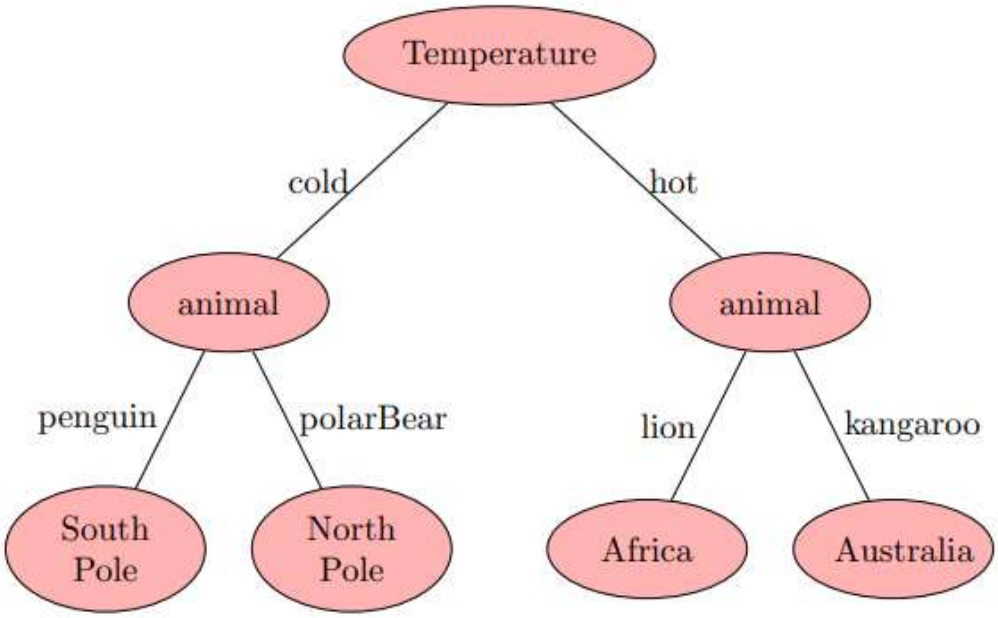

Figure 4.1: A simple node distribution in decision tree

4.7.6 Support Vector Machine

Using an N-dimensional hyperplane, Support Vector Machines (SVMs) categorise data into two categories. An attribute in SVM is referred to as a feature in the regression model, whereas the feature is referred to as a parameter. Selection of representative data is called feature selection. All the characteristics of a single individual may be summarised in a single "vector."

The primary goal of the SVM model is to find the optimal hyperplane that separates clusters with a target variable on one side of the plane and a different category on the other.. Close to the hyperplane are the support vectors. A common example of a support vector machine can be seen in the diagram below.

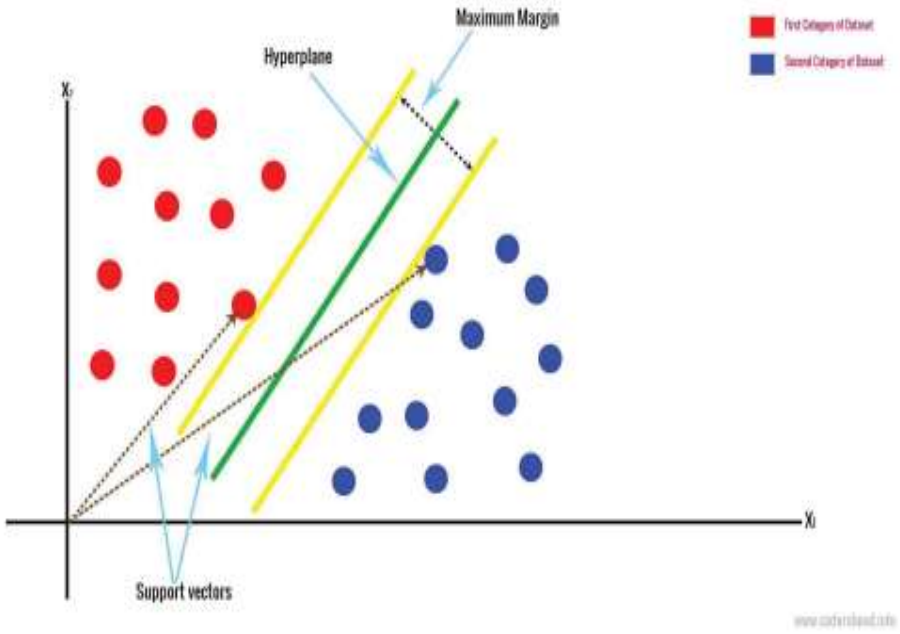

Figure 4.2: A hyperplane separating SVM data in two classes.

4.8 Artificial Neural Network

In the most basic sense, ANNs are attempts to mimic the neural network architecture of a human brain. Neurons are the fundamental building blocks of ANN. The function of a neuron is to perform various functions on to an input and provides an output. Neural networks are made up of neurons that have been linked together. After the neural networks have been created, the data is trained to reduce the error. Finally, an optimization algorithm is applied to reduce the errors even more. Artificial Neural Networks (ANNs) have a layered architecture, as seen in the diagram below.

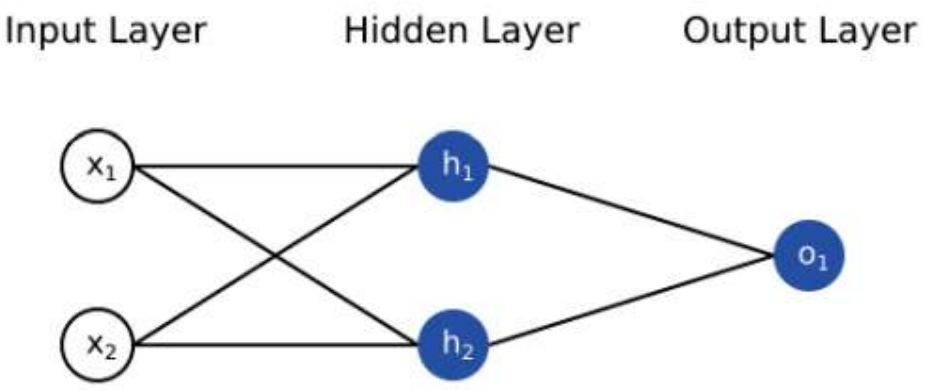

Figure 4.3: Block Diagram of Artificial Neural Network

4.9 Random Forest

RF's use of random selection and ensemble techniques allows it to make more accurate forecasts and generalizations. The random woodlands have a big amount of trees in them. The accuracy improves as the amount of uncorrelated trees grows. Random Forest classifications can assist in filling in some gaps in data. The forecast in Random Forests (RFs) is depicted in the diagram below.

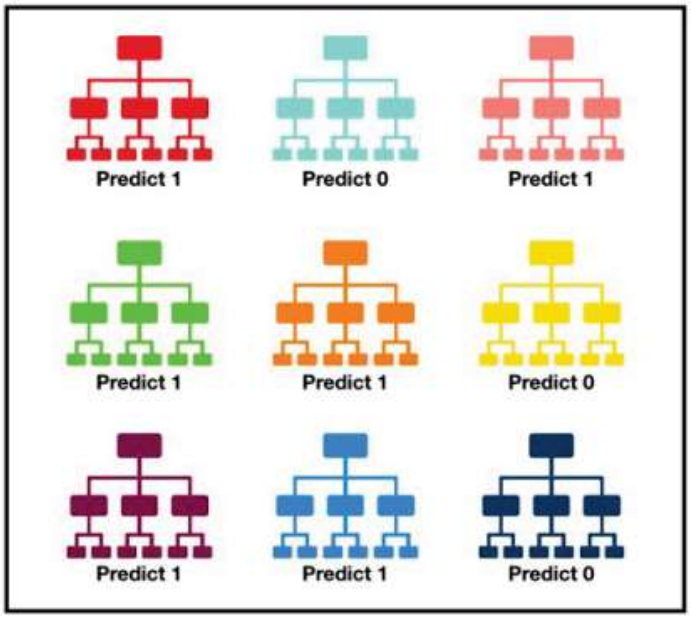

Figure 4.4: A block diagram of random forest.

4.10 K-Nearest Neighbour (KNN)

Problems may be addressed by referencing prior solutions to problems that are similar to the one at hand, a process known as "closest neighbour learning." Every instance-based learning system requires a set of parameters:

- A similarity function that compares two issues or data entries to see how similar they are. This is required in order to determine which of the new problem's neighbours are the closest.
- When dealing with the new problem, a number of neighbours are taken into account.
- A weighting function that allows for more precise quantification of discovered neighbours in order to improve prediction and learning quality.
- A function that defines where to use found neighbours to solve the following problem is described by this evaluation approach.

For example, instance-based learning approaches don't do any calculations on data prior to presenting a query to the system in this manner. While eager learning approaches like Decision Trees seek to change data before receiving queries, these methods avoid this problem.

4.11 E-learning and blended learning

The use of multiple technology instruments such as computers, tablets, and internet access to provide both synchronous & asynchronous learning and teaching in an online setting is referred to as e-learning (Sambrook, 2003). E-learning, according to Budu et al. (2018), is the implementation of Information Communication Technology (ICT) systems that improve and assist the transmission and applying knowledge in teaching and learning. Educators and students connect and communicate remotely in e-learning settings to complete a variety of academic tasks (Singh & Thurman, 2019).

An online and on-campus mix of learning is known as "blended learning." Students in on-campus courses in blended learning seem to be bound by a rigid class schedule. In a

blended learning programme, most courses will remain online, enabling students to complete assignments and evaluations while on the road (Bervell & Umar, 2020; Herman et al., 2019; Pop, 2020).

4.12 Synchronous and Asynchronous learning

Synchronous and asynchronous e-learning environments are the most common forms of virtual educational contexts. Live lectures may be streamed using learning management systems like D2L, Blackboard, or Moodle in a synchronous educational setting. It is possible for instructors and students to interact in real time during normal class hours in this learning environment (Chen & Huang, 2019; Ng et al., 2012). As well as submitting assignments in real time, students may access all instructional materials via the LMS.

On the other side, asynchronous learning refers to an uncontrolled online teaching environment. Although the LMS provides 24/7 access to learning resources as well as assignment submission, learning content of live lectures or seminars is not provided.

Synchronous learning, on the other hand, gives many potential for successful teaching and learning through social engagement (Chao et al., 2012; Mcbrien et al., 2009; Pfister & Oehl, 2009). The usage from both synchronous and asynchronous learning and teaching methodologies has come from the worldwide pandemic, which cannot be denied. This has allowed teachers to interact with their students using a variety of learning technology and pedagogies to make online sessions organic (Dhawan, 2020). Many educators and students have already been able to effectively complete respective academic semesters despite the current crisis as an outcome of the aforementioned.

4.13 The role of e-learning for emergency remote learning during COVID-19 pandemic

The desire for academic institutions to remain fluid and adaptable in the face of the virus's present difficulties has resulted in the adoption of EdTech and web - based learning platforms by most research universities throughout the world. Due to the COVID-19 pandemic, online learning has clearly become a critical solution in learning and teaching, with approximately 90 percent of the world's richest countries, including the United States, Canada, the United Kingdom, Germany, China, France, Japan, and South Korea, adopting and effectively using online learning systems.

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a worldwide disease, and online learning soared throughout Asia. Several Asian education ministries, including those in China, Japan, Vietnam, Malaysia, and the Philippines, have advocated the use of Microsoft's online learning and teaching tools. This work has allowed millions of students to study and complete their semesters at their own speed. Online learning technologies may also be used to facilitate real-time collaboration between administrators, instructors, and students in these locations (Microsoft, 2020b).

The Chinese ministry of education urged a quarters of a billion of full-time students to complete their education via digital sites like Google classroom and Zoom in mid-February 2020. With over 730,000, or 81 percent of K-12 pupils, taking school via the Google online classroom in Wuhan, this move marked the highest level of online teaching and learning in Chinese education history (Li & Lalani, 2020a; Tencent, 2020).

Furthermore, most PhD students in China, particularly overseas students, were capable of defending their dissertations via Zoom and join virtual graduation ceremonies via different livestreaming platforms. As we oppose COVID-19, there is little doubt that perhaps the disruption generated by COVID-19, as well as the incorporation of technology into teaching and learning, has become an essential component of education around the world.

In spite of the pandemic's devastating impact on various educational sectors throughout the world, the epidemic has mostly afflicted underdeveloped nations. It is possible that some students have never attended a lesson since the schools shuttered in March 2020, even if some institutions have offered online instruction. UNESCO (2020b) estimates that the epidemic has resulted in the closure of schools for 297 million African students. It was impossible for institutions of higher learning in Africa not to use EdTech to move some of their programmes online. With limited internet connection and high data costs, as well as the urban–rural digital divide, online education across the continent confronts considerable challenges. Africa's educational system is under jeopardy because of these issues. Countries like Ghana, Rwanda, Ivory Coast, Senegal, Congo, and Tanzania have been aided by UNICEF, UNESCO, and the Central Bank to improve remote learning and teaching in primary, secondary, and technical schools by using traditional mass communication methods like radio and television (Kuwonu, 2020).

In response to the massive demand for ERL in the virtual classroom, several organisations have offered some of their premium services for free for the rest of the academic year. An online course developed by IBM, Open P-TECH, aims to teach the kinds of professional and technological abilities that will be needed in the future (P-TECH, 2020).

For educational institutions that were not already licenced for Microsoft Teams, Microsoft additionally provided an unlimited free Office 365 AI with no user limitations. For academic institutions, this bundle offered unlimited chat, videoconferencing, document storage, and more (Microsoft, 2020a).

4.14 Software Environment

4.14.1 Python

Python is a high-level, general-purpose programming language. There is support for many paradigms. Python's standard library has a wide range of useful tools for a number of purposes. Many features and packages are available with the Python programming language. The experiment is run using a range of programming talents. This thesis used the following Python libraries:

- **Pandas** - It's a Python module that offers expressive data structures for both tabular and labelled data. It's a Python module that allows you to read and write data between data structures.
- **Numpy** - It's a scientific computing Python module that's free source. Numpy additionally extends Python's array processing capabilities.
- **Matplotlib** - It's a Python module for creating plots & 2D representations that's open source. It works with Python to create interactive and excellent visualization plots.
- **Tensorflow** - It is a machine intelligence open-source python module created by the Google Brain Team.
- **Sklearn** - It's a free, open-source Python machine learning framework that works with Numpy. It includes clustering, classification, and regression machine learning methods.

4.15 Proposed Framework

The research approach provided in this study describes the entire hypothesis mentioned in the subsections Specified requirements, User perceptions, and Acceptance Testing. Quality of information, content quality, system quality, service quality, user satisfaction of use, prospect theory, aimed at evaluating, satisfaction, perception mobility, intention, and real the use m-learning are all crucial elements in these three subsections. The hypothesis proposed among numerous constructs in the study model is described in Figure 1.

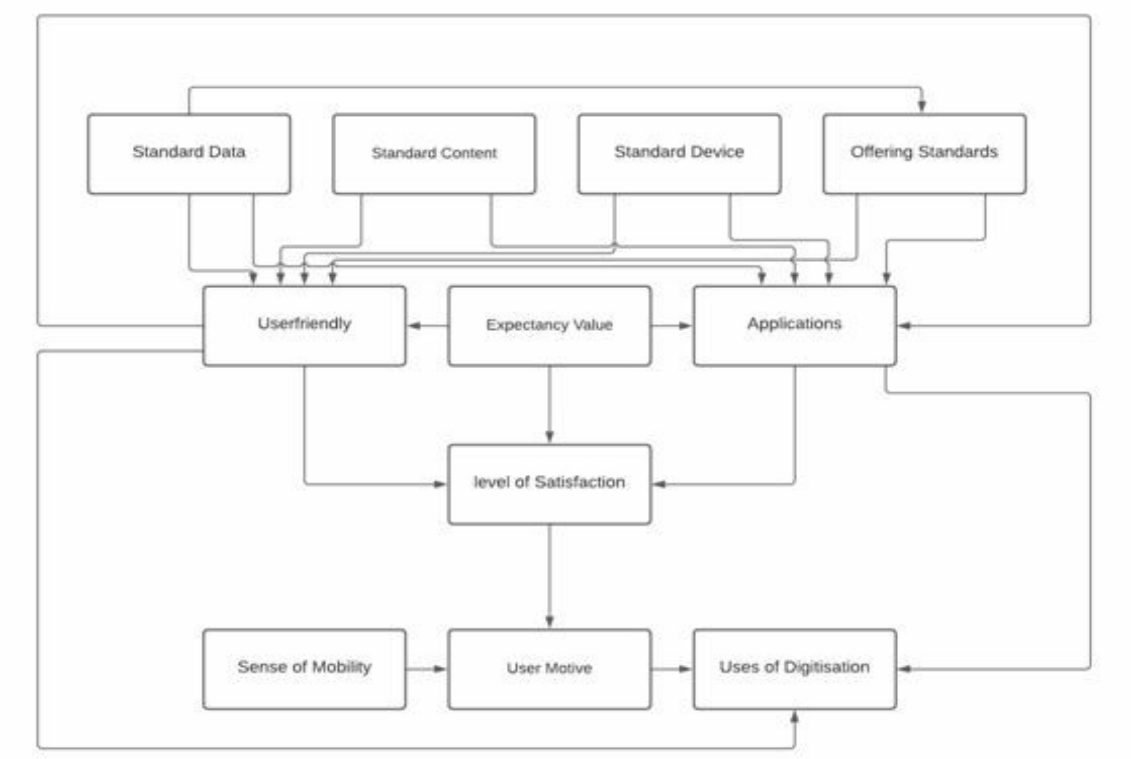

Figure 4.5: Proposed Framework System

4.15.1 Framework Specifications

Standard Data

It refers to the efficacy and quality of mobile education content, such as lecture materials, assignments, photos, and quizzes [18]. It provides users with well-defined, up-to-date, flexible, and relevant information. As a result, information quality is critical

to the evolution of mobile learning. Cheng [19] also stated that students are only driven to adapt and accept online learning if the content is of higher quality. Several prior researches have shown that the quality of information impacts pupils' adoption of mobile studying at institutions. The user satisfaction of use is influenced by the quality of the data.

Standard Contents

It's an aspect of the information quality equation. Standard content refers to improvements to both the course content and the assessment questions. In the context of mobile learning, [20] emphasizes the importance of improving the quality of content provided by all platforms. The user satisfaction of use is influenced by the quality of the content.

Standard Devices

It refers to system functionality, dependability, accessibility, ease of use, recognition, and a user-friendly interface design. According to previous study [18], the platform's quality is determined by the user's viewpoints; therefore good system quality has a favorable impact on mobile learning's ease of use and utility. The user satisfaction of use of a system is affected by its quality.

Offering Standard

It refers to the ability to access mobile services from any location and at any time. Usability, accessibility, interaction, the utility of the content, and the adequacy of the information must all be prioritized [11]. The user satisfaction of usage is positively influenced by service quality.

4.15.2 Consumer Trust on Framework

User-friendly

Davis [11] defined this idea as the extent to which the individual believes that using technology is self-sufficient or needs no effort. The term "relief from severe trial" or "autonomy from complexity" is drawn from this concept. Many studies have discovered that users' intention to utilize m-learning technology is linked to their effort probable

[22]. The perceived simplicity of use has a beneficial impact on satisfaction.

Expectancy value

Expectancy value theory is divided into three categories: intrinsic value, attainment values, and utility values. In the context of mobile learning, this concept is used to understand pupils' educational motivations and academic achievement. According to studies, the EVT is used to predict learners' intentions to complete a task quickly and their performance [25]. Expectancy value effects perceived ease of usage in a positive way. The focused point is intrinsic value, attainment value and utility value inside this section.

Applications

The TAM model was the first to utilize this concept, and it demonstrated how much a person believes that using a particular technology will help them accomplish better work [11][22]. The COVID-19 pandemic encouraged universities to transition to online education. Appearance of utility positively influences m-learning satisfaction

Level of Satisfaction:

When a learner engages with a digital platform directly, satisfaction has been defined as the happiness or confidence that the learner experiences [20]. As a result, the researchers believe that happiness has a positive effect on actual mobile learning utilization. Satisfaction has a beneficial impact on the intention to utilize m-learning in the future.

4.15.3 Consumer Adoption of Framework

Sense of Mobility

The process of learning that takes happen practically everywhere and at any time is known as mobility or ubiquity. To put it another way, it allows students to study in a challenging world [25]. This new component, mobility, was included to the UTAUT model to determine whether or not a student is familiar of it, and whether or not they

want to use mobile application [21]. The perception of mobility has a beneficial influence on the behavioral intention to use e-learning.

User Motive

It refers to a learner's intention to benefit from e - learning and to apply it all in the upcoming [24]. It has been identified as a parameter to assess that influences a learner's decision to adopt active technology [22]. The intention to use m-learning has a beneficial impact on its actual utilization.

Users of Digitization

The real application of m-learning relates to whether or not mobile learning technology is used. It is the TAM model's final construct, and it has no bearing on the previous constructs [26]. Previous research has suggested that this function Object component is crucial, and that it may be used to explore how learners actually use mobile learning by looking at a variety of characteristics. As a result, there is no theory for this concept.

4.16 METHODOLOGIES

During in the COVID-19 pandemic, a review of e-learning was conducted

COVID-19, according to Li [26], has had a global influence on education, forcing nearly 1.2 billion pupils out of the classroom and necessitating the exploration of alternative methods of educating schoolchildren. They claimed that since the outbreak of COVID-19, language apps, virtual mentoring, video conferencing tools, and e-learning software have exploded, with educational investments expected to rise from USD 18.66 billion in 2019 to USD 350 billion by 2025, triggering many systems to give out free classroom services. BYJU, a Bangalore-based educational technology business that specialized in online tutoring, was launched in 2011 and has since grown becoming the world's richest EdTech Company. However, other researchers [15][13] believe that e-learning falls short of classroom learning due to a lack of access to digital resources

such as computers, web access, as well as the digital literacy. Likewise, discovered that in the COVID-19 era, less than half of American pupils are attending online classes caused by chronic absence and non-performance of assignments. Discovered that just 21.3 percent of students had access to computers in their schools in 2018 [21], while

Lau argue that a true university environment is indispensable and essential for deep understanding.

Theoretical Framework

Over time, it depicts how a new technical invention spreads and becomes more popular in a given demographic or social system [16]. One way to express it is that new concepts, behaviours, or products that are embraced by a group of people in a certain social system spread to other members of the same social system or bigger groups who are not part of that social system. This theory, established in the late 1800s by Watson and B.F. Skinner, focuses on how pupils learn. All behaviours are taught via interaction with the environment, and intrinsic or hereditary features have minimal impact on behaviour [17] [19].

Data Collection for Theoretical Framework

During COVID 19, online questionnaires were issued to students who are currently utilizing mobile learning technology for study to better understand their perceptions of various aspects affecting mobile learning uptake. The sole way to collect data in this study, specifically during COVID-19, is to use an online questionnaire. Students from a single Meerut college are among the participants. As a result, an online Google form was used to record the responses of 1439 students. Because the questions are identified as mandatory, any partial or invalid responses are successfully prevented in this study. Furthermore, the study attempted to obtain primary genuine data from all college students.

Data Collection for Theoretical Framework

This study takes a quantitative approach. The items for the questionnaire were derived from previous literature, with some new questions included in case of the COVID-19 circumstance. To test the constructs in the proposed framework, a five-point Likert-type scale with few values was used as the measurement scale, spanning from Strongly Disagree to Strongly Agree.

4.11 Result Discussions

Data Analysis

To analyze the data and evaluate the proposed theoretical model for this study, we used machine learning algorithms. Machine learning is a method for accurately predicting future events using both existing data. Machine learning algorithms solve difficult problems by training the model and testing it on current data to get efficient results. It forecasts the dependency or predicted links between the independent and dependent variables affecting student opinions on digital learning acceptability in the scope of this research.

Theoretical Framework Validation

The proposed hybrid theoretical model's links between its many components are being investigated using machine learning classifiers. There are several ways to classify a dataset, including Logistic Regression, Support Vector Machines, Nave Bayes, Decision Trees and K-Nearest Neighbors (KNN). Table 4.1 includes the following:

Table 4.1: Representing prediction among algorithms and user-friendly

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	89.05
2	Support Vector Machine	89.44
3	K-Nearest Neighbor	96.02
4	Decision Tree	84.41
5	Nave Bayes	91.57
6	Random Forest	96.87

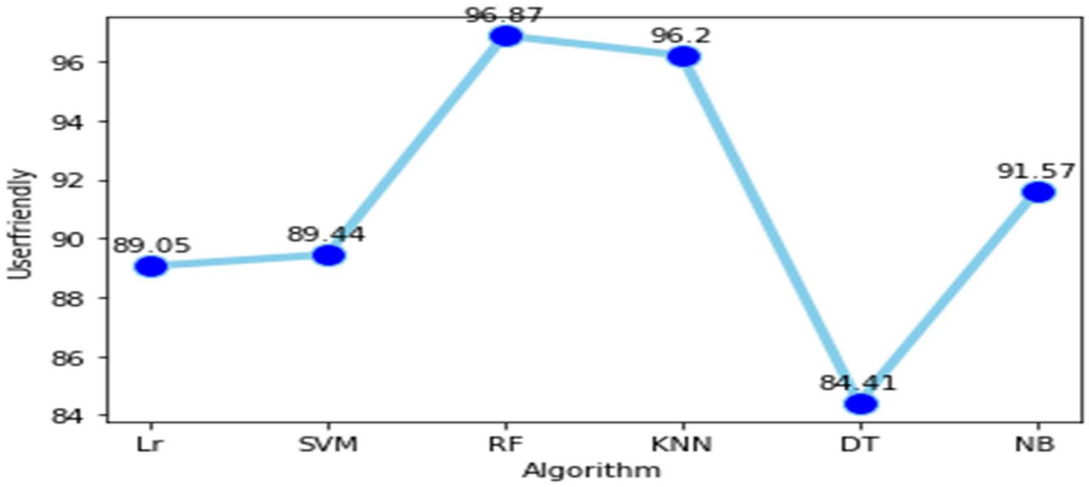

Figure 4.6: Accuracy analysis prediction among algorithms and user-friendly

Table 4.2: Representing prediction among algorithms and application

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	87.32
2	Support Vector Machine	88.01
3	K-Nearest Neighbor	94.27
4	Decision Tree	85.61
5	Nave Bayes	89.02
6	Random Forest	94.43

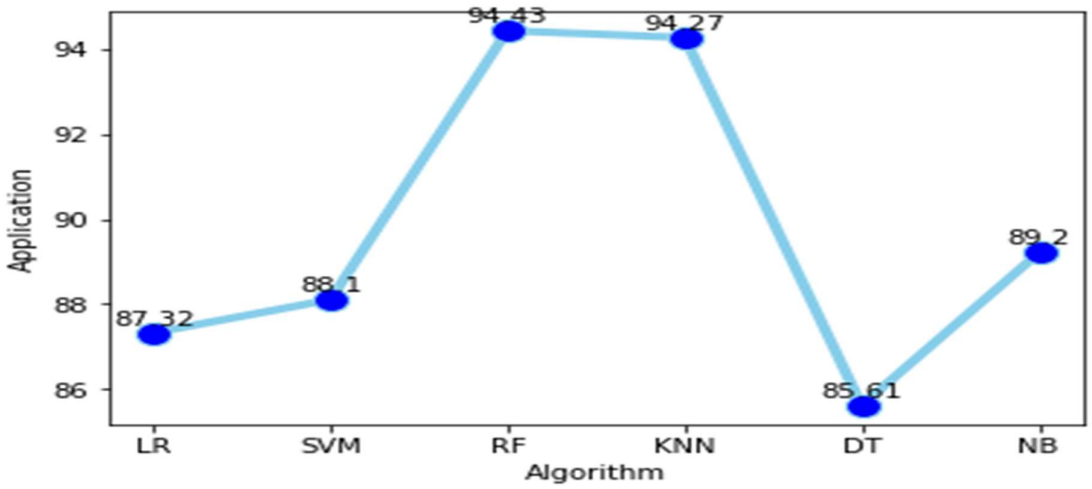

Figure 4.7: Accuracy analysis prediction among algorithms and application

Table 4.3: Representing prediction among algorithms and offering standards

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	80.07
2	Support Vector Machine	78.01
3	K-Nearest Neighbor	78.77
4	Decision Tree	76.05
5	Nave Bayes	80.04
6	Random Forest	81.59

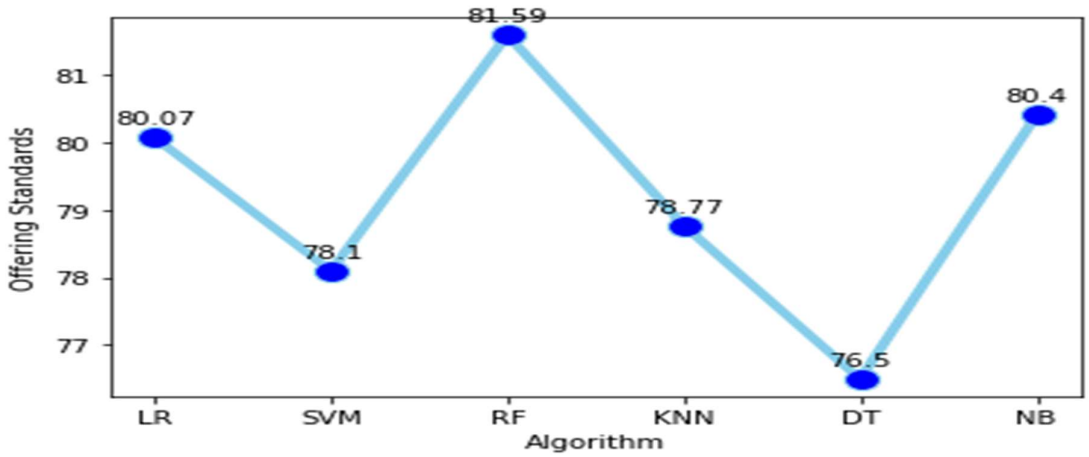

Figure 4.8: Accuracy analysis predictions among algorithms and offering standards

Table 4.4: Representing prediction among algorithms and Level of Satisfaction

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	78.64
2	Support Vector Machine	80.79
3	K-Nearest Neighbor	90.02
4	Decision Tree	82.76
5	Nave Bayes	80.29
6	Random Forest	91.87

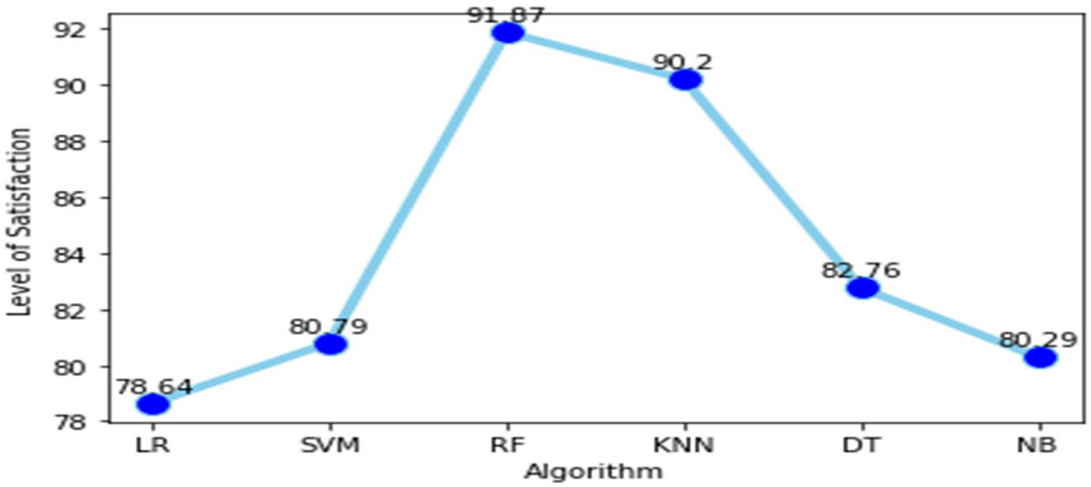

Figure 4.9: Accuracy analysis predictions among algorithms and Level of Satisfaction

Table 4.5: Representing prediction among algorithms and user motive

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	90.76
2	Support Vector Machine	90.68
3	K-Nearest Neighbor	91.88
4	Decision Tree	89.63
5	Nave Bayes	89.29
6	Random Forest	91.01

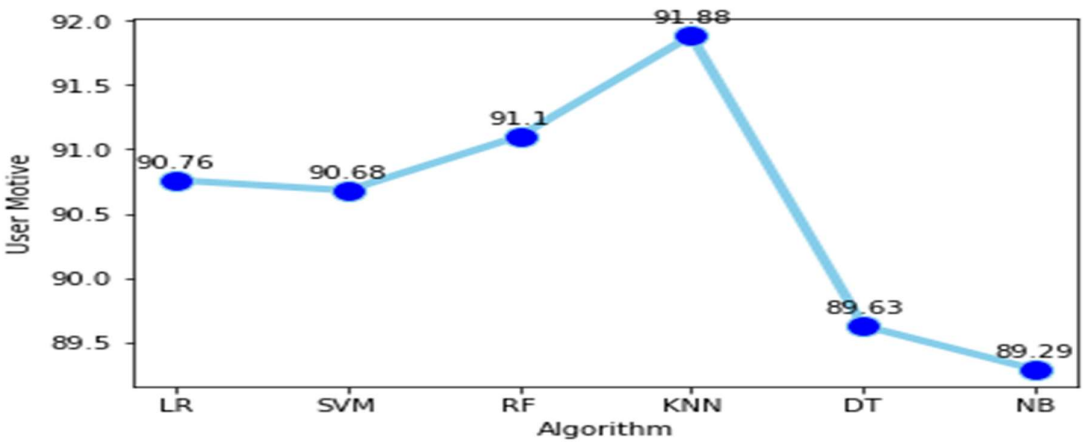

Figure 4.10: Accuracy analysis predictions among algorithms and user motive

Table 4.6: Representing prediction among algorithms and uses of digitization

S. No.	Different Algorithms	Performed Algorithms Accuracy
1	Logistic Regression	93.47
2	Support Vector Machine	93.75
3	K-Nearest Neighbor	91.03
4	Decision Tree	93.52
5	Nave Bayes	87.29
6	Random Forest	94.07

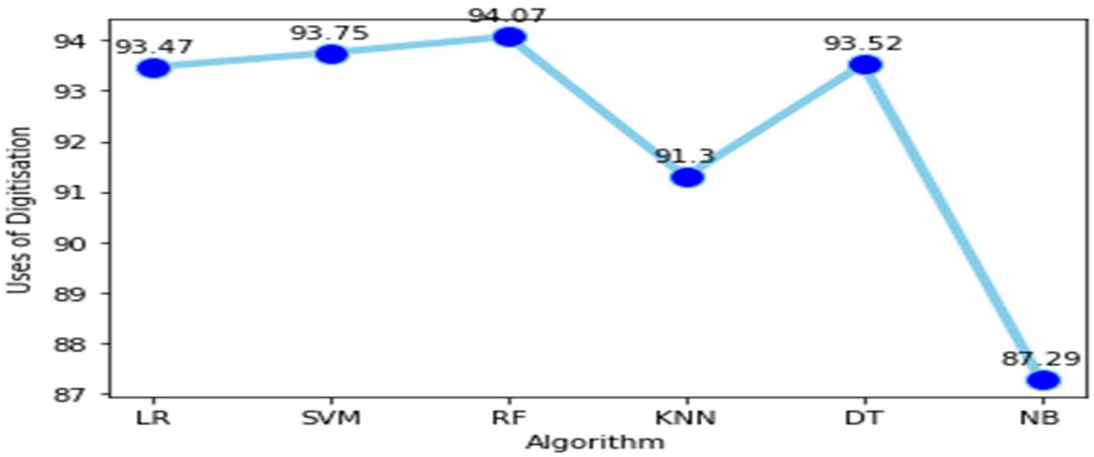

Figure 4.11: Accuracy analysis predictions among algorithms and uses of digitization

4.18 Sampling and Questioners

Examining the four study topics immediately structures the data presentation and analysis. The data acquired from the poll revealed that women made up 64.6 percent of the respondents, while men made up 30.1 percent. Furthermore, 61.4 percent of the respondents were university students, 33.5 percent were students at technical institutes, 5.3 percent were college students, and 4.2 percent were school pupils. Table 1 shows the different levels of pupils who took part. Table 2 shows the extent to which Indian education system used e-learning throughout the COVID-19 period. During the COVID-19 pandemic, free learning platforms like Google Classroom, WhatsApp, and Zoom were particularly popular, according to the poll, with the majority of the alternatives being Google Classroom, WhatsApp, and Zoom.

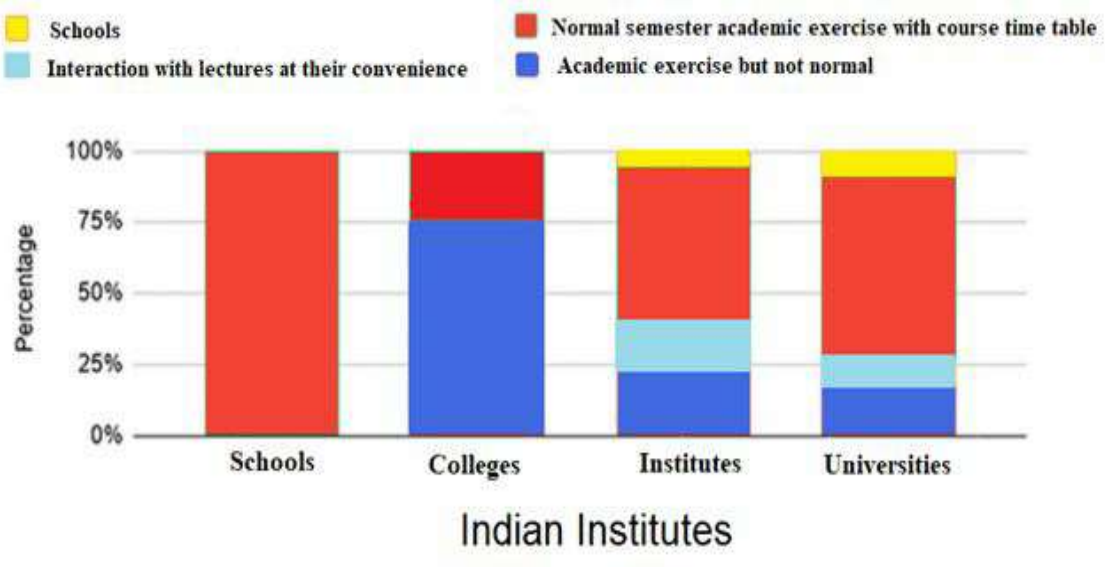

Figure 4.12: Shows the level of academic learning in Indian schools during the COVID-19 pandemic.

Table 4.7: Shows the academic levels of students who took part in the survey from the Indian educational system.

Category of Education	**Participation of People**	**Percentage of Participation**
Schools	146	10.14
Colleges	280	19.45
Technical Institutes	697	48.43
Universities	316	21.95
Calculating Values	1439	100

Table 4.8: Shows the different types of class mode given by Indian students during the COVID-19 epidemic.

Classroom Mode	**Participation of People**	**Percentage of Participation**
WhatsApp Platform	141	9.79
Zoom Platform	227	15.77
Skype Platform	128	8.89
Webex Platform	163	11.32
Google Meet	301	20.91
Google Classroom	412	28.63
Google Duo	67	4.65
Calculating Values	1439	100

Table 4.9: During the COVID-19, Indian students used a lecture approach.

Delivery Mode	**Participation of People**	**Percentage of Participation**
Text Format	278	19.31
Audio Format	327	22.72
Video Format	314	21.82

Multimedia Format	233	16.19
Camera Based	165	11.46
Combined All	122	08.47
Calculating Values	1439	100

Many internet classes in Table 3 were primarily text-based, which could be linked to text consuming less bandwidth than audio and video services. This is notable since during the COVID-19 pandemic, one out of every ten students did not participate in any online learning.

Table 4.10: Students in the Indian education system faced several problems during the COVID-19 pandemic

Online classes Issues	**Participation of People**	**Percentage of Participation**
Internet	378	26.26
Power Supply	227	15.77
No Enough Data	279	19.38
Boring Classes	183	12.36
Background Noise	198	13.75
Laziness	174	12.09
Calculating Values	1439	100

According to Table 4.10, the challenges can be divided into four broad groups. Cluster

one, which includes poor infrastructures, accounted for 26.26 percent, cluster two, which looked at personal factors, accounted for 15.77 percent, cluster three, which dealt with financial power—namely, the inability to buy enough data—accounted for 15.77 percent, and cluster four, which looked at environmental factors, accounted for 15 percent. These findings suggested that throughout the COVID-19 period, infrastructural issues were the most important impediment to effective online learning by Nigerian higher education students, followed by personal and environmental factors. Financial factors were the least troublesome for online learning's success.

CHAPTER 5

CONCLUSIONS AND FUTURE RESEARCH

5.1 CONCLUSION

In this thesis, we presented an efficient structure in healthcare domains for certification of testing kits utilising Blockchain technology. We also provided a measuring index with the help of machine learning which targeted students involved in digitized education. How much the students are perceiving knowledge given via digitized platforms in the pandemics like COVID has been clearly evaluated.

- We targeted numerous businesses who are interested in supply chain management and applying this supply chain management by R3 Corda. In this study we also cover alternative tools and working scenarios of the proposed framework. In the future, this works increasingly extended in multiple ways i.e. initially, we can remove the need of the third-party application, at the same time we can also replace various aspects in constructing for generating a more secure system and ease of use has been improved concurrently. On the other hand, nodes in the chain may expand according to the need for constructing complicated chain if required and additional material can be added to the chain in the form of files. Lastly, we may utilise this framework in other associated study domains since currently, validation of things necessary in every sector for making their dependability more strong and we have to make all methods public by which consumers' confidence rise appropriately. So in brief we may apply this framework in other similar domains.

- In comparison to previous research that looked at a wide number of parameters, the results are similar. The present epidemic has forced education to move away from the traditional classroom and toward online and mobile learning environments. Following this investigation's findings, machine learning methods were utilised to discover elements from students' perceptions that impact people' attitudes toward mobile learning for studying at COVID-19, which was conducted as part of the COVID-19 conference. Only a few studies have utilised machine learning to predict the components' characteristics. As a result of the data and study, we are able to make broad generalisations about digital learning

consumption among students during COVID-19. We will concentrate on student views during COVID-19 and use machine learning to do so. The results also highlight crucial aspects to consider when developing mobile learning systems with the goal of increasing the number of students who utilise e-learning for educational reasons. It will also help educators better understand how students perceive these aspects, which will aid them in developing more effective mobile learning teaching methods.

- In last, we wish the current pandemic COVID-19 must be eradicated as soon as possible. This doesn't imply we can't apply this system after this pandemic is over, as previously talked that above say framework/structure may be actualized in distinct regions which may suffer localized effect of a pandemic or rather we can say epidemic also.
- Validation of things required in every field for making their reliability more strong and we have to make all procedures transparent by which users trust increase correspondingly. So in short we can use this framework in other related areas.

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