EVALUATE HOW BLOCKCHAIN TECHNOLOGY CAN PREVENT FALSIFIED DRUGS AND MEDICAL DATA BREACHES IN INDIAN HOSPITALS

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THEREQUIREMENTS FOR THE DEGREE OF

MSc in Pharmaceutical Business and Technology (QQI)

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STUDENT DECLARATION

I hereby certify that the dissertation entitled “Evaluate how blockchain technology can prevent falsified drugs and medical data breaches in Indian hospitals”, is submitted for the degree of receiving MSc in Pharmaceutical Business and Technology. I declare that this dissertation is completely my own work and have given proper credit as well as an acknowledgment to all sources cited in the study.

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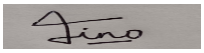
Candidate Signature: 

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ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to God Almighty for his blessings, which enabled me to successfully finish my work.

I would like to express my sincere gratitude to my esteemed research supervisor Brendan McLaughlin for his guidance, support, as well as inspiration, which were instrumental in presenting my research study in the best way.

I owe my family a debt of gratitude, especially my mother Jessy, for her prayers and support throughout my dissertation. I would like to express my gratitude to all the respondents in the survey, who willingly gave their time as well as knowledge to participate in my survey study. Lastly, I would like to thank my friends Feba and Ashley for their support as well as care throughout my dissertation. I want to convey my gratitude to everyone who has supported me to finish the research work

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

EHR - Electronic health records

HER - Hospital information systems

HGD -Healthcare Data Gateway

LGE-HES -Lionized Golden Eagle Lionized Golden Eagle based Homomorphic Elapid Security

WHO- World Health Organisation

ABSTRACT

EVALUATE HOW BLOCKCHAIN TECHNOLOGY CAN PREVENT FALSIFIED DRUGS AND MEDICAL DATA BREACHES IN INDIAN HOSPITALS

Jino Sarah Anil

The sale of fake drugs, as well as medical data hacking, are significant threats to the healthcare sector. These problems can cause severe repercussions like financial loss and compromised patient safety as well as privacy. Fake drugs and medical data hacking are highly prevalent in Indian healthcare because of its large population as well as its complicated healthcare system. Blockchain is an innovative technology that helps to prevent these issues in healthcare. Blockchain is used to develop innovative concepts in a wide range of sectors, especially in healthcare. Blockchain technology is employed in a few hospitals in India but the wide adoption of blockchain is one of the aims of this research study**.**

The aim of the research study is to find out the consequences of falsified drugs such as negative impacts on the health of the patients, and financial loss for healthcare providers. Furthermore, the research study will explore the repercussions of medical data hacking in the Indian healthcare industry. This study also investigates how blockchain can help to prevent these problems in Indian hospitals. Apart from that, the researcher will examine the challenges of implementing blockchain technology in Indian healthcare and give recommendations on how to effectively employ blockchain technology in Indian hospitals.

In this research study, a quantitative method was employed. The findings of the study were collected by sharing a questionnaire consisting of 13 questions. A cross-sectional study was conducted among various healthcare professionals working in the Indian healthcare system. The questionnaire was designed in such a way that it meets the goal, aim as well as objectives of the research study. From the studies, it is evident that Blockchain technology is the best solution to prevent fake drugs as well as medical data hacking in Indian healthcare, and in the future, it has the potential to advance its practice in healthcare sectors. However, limited awareness is the major challenge in implementing blockchain in the healthcare sector.

It can be concluded that this research study will help to comprehend the consequences caused by falsified drugs as well as medical data hacking in Indian healthcare. Moreover, the study clearly demonstrates the potential of blockchain technology as an innovative solution to tackle the problems in the healthcare sector. The findings of the research study are expected to provide a deep understanding for healthcare professionals on how to use blockchain technology to prevent falsified drugs and medical data hacking in the medical field. The use of blockchain technology is anticipated to be extensively adopted by all Indian hospitals as well as international healthcare settings. Moreover, internationally, blockchain is predicted to gain more prominence in the healthcare industry in the coming years. The research study concluded that the implementation of blockchain technology in all Indian hospitals can help to prevent the entry of falsified drugs as well as data hacking.

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Falsified medications, as well as medical data hacking, are two significant issues in healthcare that can jeopardize patient safety and well-being. Falsified medications can be ineffective and even poisonous, while hacked health records could be exploited for theft as well as compromise patient privacy. Such problems are particularly prominent in India, where the population is enormous making it difficult to track and trace pharmaceuticals or monitor patient data. Electronic health records (EHR), as well as hospital information systems (HIS), have been widely employed throughout the world. Nevertheless, current Hospital information systems are primarily cloud-based, held by a single data contractor, and have several drawbacks, including a lack of adequate security precautions (Elangovan *et al.*, 2022). These have led to much data theft, as well as issues with data quality and information sharing, rendering individuals at risk of financial risks or even public stigma. Blockchain technology is one potential solution to these issues. Blockchain is a distributed, decentralized ledger technology that enables secure, transparent, and tamper-proof transactions as well as record-keeping. In a blockchain network, data is stored in blocks that are linked together in chronological and sequential order, forming a chain of blocks. It is a decentralized and secure ledger that may be used to monitor and verify transactions involving pharmaceuticals or medical data. Hospitals in India should use blockchain to develop a safe, transparent, and tamper-proof system (Katuwal *et al.*, 2018).

Blockchain is an innovative technology that is being employed to develop innovative concepts in a wide range of sectors, especially in healthcare. In the healthcare sector blockchain technology is employed to store as well as share patient information among hospitals, pharmacies, and physicians. Apart from that, it has the potential to improve the efficiency, visibility, and security of medical data sharing in healthcare. This technology enables health organizations to delve deeper and improve the analysis of medical records. This is a distributed database containing transaction information that is authenticated as well as managed by a network of computers located worldwide. Healthcare systems are swamped with issues such as the absence or inappropriate maintenance of health information and information privacy and security problems. Blockchain is a novel technology and it has the potential to enhance the core

area of healthcare by enhancing the connectivity as well as the optimization process, while ensuring privacy and security of the data (Zakari *et al.*, 2022).

The involvement of large number of stakeholders makes the hospital supply chain very complicated. The efficacy as well as seamless functioning of the supply chain is based on a variety of aspects including smooth information sharing between the stakeholders, smooth movement of drugs (Hölbl *et al.*, 2018) .The effectiveness of a supply chain in hospital impacts not only the price but also the clinical outcomes of the patients. So, the innovative as well as enterprising technology like blockchain should employed to assure a tamper proof and efficient supply chain in healthcare system (Buowari, 2012a). Nevertheless, employing blockchain technology in the Indian medical sector requires substantial expenditures in equipment and training, as well as resolving legal concerns related to data security and confidentiality. However, the possible benefits of applying blockchain for preventing counterfeit drugs and medical data breaches in Indian healthcare are significant and demand more research.

Figure 1 showing features of blockchain technology (Priya Isravel,Martin Sagayam, 2015)

1.2 RESEARCH PURPOSE

The purpose of the research study is to evaluate how blockchain technology can prevent falsified drugs and medical data breaches in Indian healthcare. It is anticipated that this research study will provide insights on the benefits of adopting blockchain technology in the healthcare sector to prevent fake drugs as well as medical data breaches. The study will be focusing on the consequences of fake drugs and medical data hacking healthcare. Apart from that, this research investigates the challenges of implementing blockchain technology and usefulness of blockchain technology in preventing fake drugs and medical data breaches. The findings of the research study will help the healthcare professionals and researchers to comprehend the consequences of data hacking as well as fake drugs in the healthcare system and challenges of implementing blockchain in healthcare sector. This research study helps to expand awareness and comprehension of blockchain's potential benefits and in future hospitals will possess sufficient trust in employing this kind of technology for keeping and exchange of medical information. Similarly, the people may be understanding the changes should be made in the healthcare sector to adopt this novel technology. This research study helps to create awareness about introducing blockchain in all healthcare sectors.

1.3 RESEARCH AIM

The research aim is to find out the problems caused by falsified drugs and medical data hacking in healthcare and to outline, how blockchain helps to preventing fake drugs and medical data hacking in Indian hospitals.

1.4 RESEARCH OBJECTIVES

- To find out the Consequences of fake medicine and medical record hacking in healthcare.
- To evaluate how blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian hospitals.
- To find out the Challenges in implementing blockchain in Indian hospitals.

1.5 RESEARCH QUESTION

- What are the consequences of fake medicines and medical data hacking in healthcare?
- How blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian healthcare?

- Examine the challenges in implementing blockchain in Indian hospitals?

1.6 SIGNIFICANCE OF THE STUDY

The research study was undertaken because it has significant implication for the healthcare sectors in India and it can also contribute in the advancement of technology as well as knowledge. This topic is highly relevant because during the pandemic there were huge supply of inferior drugs to the hospital and several patient data were hacked. So, the implementation of blockchain technology in the hospital sector would assist to avoid the distribution of fake drugs and improve transparency and accountability in Indian hospitals. The research study can provide helpful insights into how technology could be utilized to enhance the safety as well as quality of healthcare sector in India. The study's findings could have practical implications for Indian healthcare facilities, health care providers. Whether the use of blockchain technology proves to be highly successful in preventing counterfeit pharmaceuticals and medical data breaches, then it can be employed by all hospitals in order to enhance the security of patients and maintain sensitive data. The study can aid in technical innovation by exploring the potential advantage of blockchain technology to solve the challenges in the healthcare.

1.7 DISPOSITION OF THE STUDY

This dissertation comprises five chapters Each chapters focuses to attain the research goal. First chapter provides a brief outline and summary of the topic. The aim and objective of the study are delineated in this section. Chapter two is the literature review, which covers prior findings, gaps. The methodology, it is the third chapter, which outlines the study design, paradigm techniques. Apart from that, it also discusses techniques used for collecting as well as analysing the data. The results of the gathered information are discussed in the fourth chapter. This section explains as well as summarises the result obtained from the primary data sources. Discussion and conclusion are explained in the fifth chapter. This section includes key findings of the research topic, recommendations and limitation of the research study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The review of literature section aims to offer background information and insights regarding a particular subject and concept so that readers can properly comprehend it before delving into research. The blockchain technology described in this dissertation is a relatively new topic.

2.2 BASIC CONCEPT OF BLOCKCHAIN

Blockchain technology originally appeared as the cornerstone of the Bitcoin crypto-currency system. This was suggested in 2008 and then adopted in 2009. Blockchain is a public ledger in which all transactions are recorded in a developing chain of blocks. Nevertheless, the three most famous blockchain platforms that enable smart contracts are Ethereum, Codius as well as Hyperledger. Among them, Ethereum is the most popular blockchain system, enabling a completely decentralized Ethereum computer virtual computer that handles smart contracts. Blockchain is developed by combining hash, consensus method as well as encryption technology. Blockchain works as a distributed ledger, which maintains all information in an immutable manner as well as this is connected by a variety of organized data blocks. High accuracy, decentralization, and trustworthiness are the major features of blockchain (Jayaraman *et al.,* 2019).

Blockchain is a distributed ledger, which aids to protect and securely record all transactions. It is a decentralized database that is managed by many computers. Every block in the chain seems to have a record of numerous transactions. Furthermore, each block is linked to the preceding block in the chain, which generates a chronological sequence. Therefore, altering any record in the blockchain is extremely difficult. Transparency, as well as immutability, are the key advantages of the blockchain (Elangovan *et al.,* 2022). Blockchain has many potentials uses in both the healthcare and pharmaceutical industries. Blockchain-based healthcare systems could enhance the safety and integrity of patient records. Such technologies might also assist in the integration of patient information, facilitating the sharing of health records across different healthcare organizations Blockchain is expected to have a substantial influence on the

healthcare field, even if still early stage. The field of study seems to be growing fast (Agbo *et al.*, 2019).

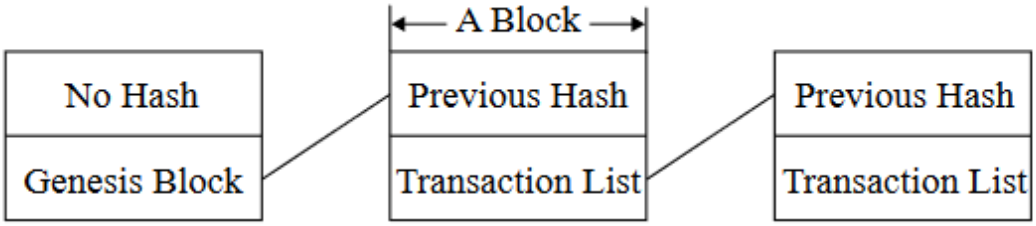

Figure 2 Structure of blockchain (Jennath et al., 2020)

2.3 TYPES OF BLOCKCHAIN

- Public blockchain

A public blockchain is available to everybody and is not the exclusive property of any individual, group or organization. Everyone can in the consensus process as a node and retain a record of the data in their databases.

- Private blockchain

Private blockchains are permissioned systems that can control which nodes can execute payments, perform out smart contracts, or participate in mining. Blockchain platforms that solely support private blockchain platform are Ripple as well as Hyperledger Fabric.

- Hybrid blockchain

These blockchain are also referred as consortium. In this blockchain, only limited number of nodes to perform in distributed consensus.

2.4 FEATURES OF BLOCKCHAIN

- ✓ Immutable: blockchain information cannot be changed, every record includes a permanent record of each transaction. It promotes trust in transactions tracking and documentation.
- ✓ Decentralized; A decentralized system of information is a blockchain. It is an open ledger of documented transactions it is available to everyone in the network.

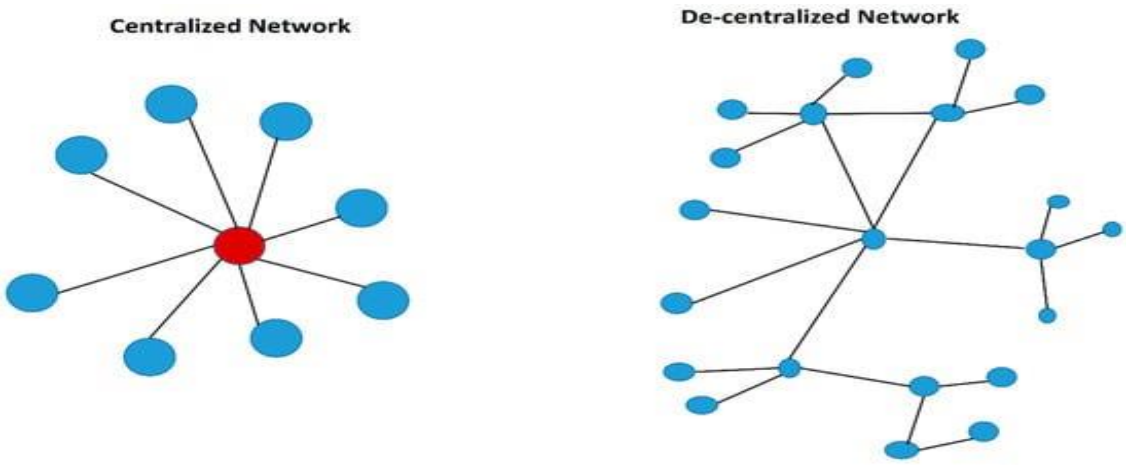

Figure 3 showing the centralised and decentralised network (Chattu et al., 2019)

- ✓ Transparent

  Each participant can access the blockchain or verify transactions due to it being an Open file. As a result, traceability is maintained (Sultan *et al.*, 2018).
- ✓ Consensus driven

  Every block on the ledger is separately evaluated through consensus models, which define the procedure for verifying a block as well as constantly making use of limited resources (like computing power)In bitcoin ,it is known as mining process (Sultan *et al.*, 2018).

PRINCIPLES OF BLOCKCHAIN TECHNOLOGY

First, all the participants in the blockchain network can access as well as verify to data. Secondly, the direct communication occurs between the peers. Thirdly, recorded transactions in the block cannot changed. Data stored in the block are linked to the previous block. When a new block is added, it is connected to the whole blockchain.

One of the popular and interesting blockchain type is Ethereum. The main objective of the Ethereum is to provide a framework for the implementation of smart contract on the blockchain. Smart contract employs a consensus algorithm to ensure proper implementation as well as operation. A contract includes a collection of commands that may be coded in its computer language. A user is required to approve every new transaction carried out in blockchain. The ‘block’ in blockchain grow more and each transaction need to be verified by

all nodes in the network. The process flow chart of blockchain is shown in figure 4 (Uddin *et al.*, 2021).

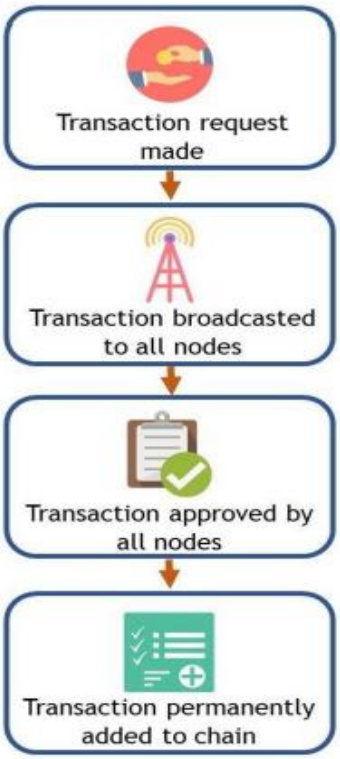

Figure 4 Process flowchart of blockchain (Siyal et al., 2019a)

2.5 CONSEQUENCES OF FAKE MEDICINE AND MEDICAL RECORD HACKING IN HEALTHCARE

Blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian hospitals. Fake medication, as well as medical record hacking, are two significant challenges in the healthcare sector that have serious repercussions for patients and society as a whole. The problem of counterfeit medications is prevalent, affecting equally developing and developed countries. False medication may be threatening people's welfare by delivering ineffective therapy and containing hazardous substances, while medical record hacking may be compromising sensitive patient records, leading to data theft, and insurance scam. As defined by the World Health Organisation (WHO), fake medications have been deliberately as

well as illegally mislabelled in terms of identity or source. Furthermore, Medication may be include inert compounds, inactive ingredients in incorrect doses (Buowari, 2012b).

2.6 CONSEQUENCES OF FALSIFIED DRUGS IN THE HEALTHCARE

Buowari, highlights different adverse reactions as well as risks involved with counterfeit medications. Falsified drugs have incorrect ingredients, and inappropriate dosage. Individuals taking these medicines have the possibility of not receiving the appropriate medical attention they need, which could lead to treatment failure or an exacerbation of the underlying disease. The major consequences of falsified drugs are

- **Failure of the treatment** -Falsified drugs contain incorrect ingredients, and these medications deprive the patients of the necessary medical care, which can result in the failure of the treatment, disease recurrence, antibiotic resistance and even death. This may lead to a loss of trust by the patients.
- **Loss of trust in the healthcare system**- Medicinal or adverse events lead to a loss of trust in the healthcare system as well as the drug control system. Patients may be lose confidence in healthcare professionals and pharmaceutical companies that expend a huge amount of money in creating new medicines and may be suffer financially as a result of the product's reputation harm (Buckley *et al.*, 2013a).
- **Organ damage** consumption of falsified medications can seriously harm the liver, kidney as well as nervous system. The liver is in charge of breaking down drugs whereas the kidney removes them from the body. When these toxics enter the body, they can harm the vital organs.
- **Economic loss** of the healthcare can occur. It's indeed harmful to take the wrong medicine or a counterfeit. It impacts the person's income due to the rising expense of treatment.
- **Wrong vital sign values** the consumption of the falsified drugs can lead to wrong vital sign values.
- **Toxicity or adverse drug reactions** The use of falsified drugs in the vulnerable groups of patients with adverse effects as well as therapeutic failure may be clinically disastrous and it could result in an augmented mortality rate (Seiter, 2009).

According to Buckley, the book discusses how falsified and substandard drugs impact healthcare systems, the business, and the patient's health as well as the general public. Especially in low and middle-income nations, counterfeit and substandard medicines may be greatly affect the healthcare system**.** Therapeutic failure, antibiotic resistance, and serious

adverse effects are the major consequences of counterfeit as well as substandard medications. Apart from that, the entry of falsified drugs into the healthcare decreases the effectiveness of health care. It can increase cost in healthcare and put more pressure in the healthcare system. Furthermore, the consumption of the falsified drug in healthcare leads to the wrong diagnosis of the disease and may be lead to a hazardous therapy (Buckley *et al.*, 2013b)**.**

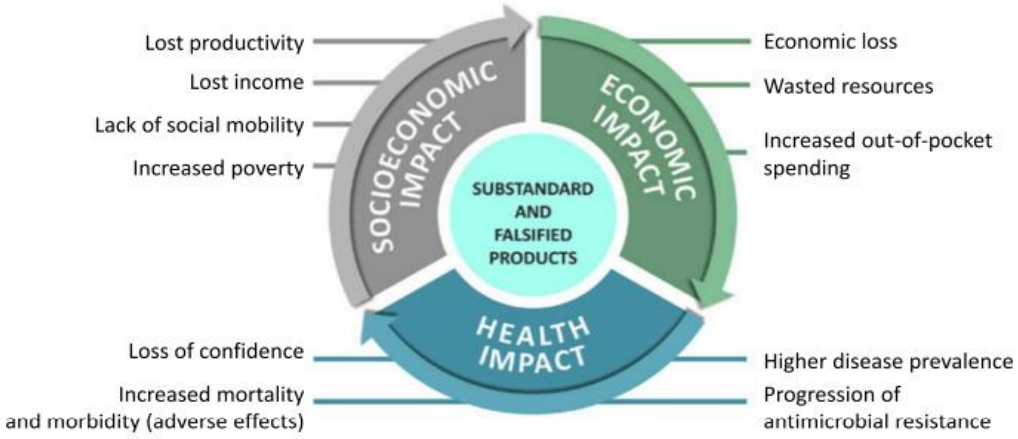

Figure 5 showing the impact of falsified drugs (Buckley et al., 2013a)

2.7 CONSEQUENCES OF DATA HACKING IN THE HEALTHCARE

A data breach is defined by the US Department of Health and Human Services as the unauthorized use or disclosure of private patient data which jeopardizes its confidentiality or reliability under the privacy act and continue to pose an adequate danger of monetary, damage to reputation, or another kind of danger to the affected individual (Seh *et al.*, 2020a).

According to Kamoun and Nicho, the consequences of medical data hacking in healthcare are highly confidential and sensitive personal information, so confidential data hacking can cause financial consequences as well as Unprecedented legal risks (Kamoun and Nicho, 2014). The consequence of data hacking in healthcare are

- **Reputational harm** -Healthcare organisations that endure data hacking may be suffer reputational harm. Patients are likely to lose trust in a healthcare service, which had a medical data hacking incident. Patients may be reluctant to share their personal

information as well as sharing sensitive data in the hospital, where data hacking occurs (Wikina, 2014).

- **Financial loss** -Financial cost of data hacking which include direct cost and indirect cost. Direct cost can include items such as expense based Clean-up cost such as investing fund for security measures to restrict the future data breaches in healthcare, recruiting forensic experts as well as providing protection service to the victims and indirect costs such as patient loss as well as reputational damage can affect the revenue of the healthcare (Seh *et al.*, 2020a).
- **Hacking of patient privacy** medical data include credit card, social security number as well as bank account number. With the help of these details hackers can make fake identities to purchase resaleable medicinal products or medications or they can link a person's number with fake provider number and make false insurance claims. Furthermore cyber hackers can blackmail the patients with the help of these data(Khan and Hoque, 2018) .
- **Legal consequences** Medical data breaches in healthcare can lead to potential regulatory fines (Meisner, 2017).

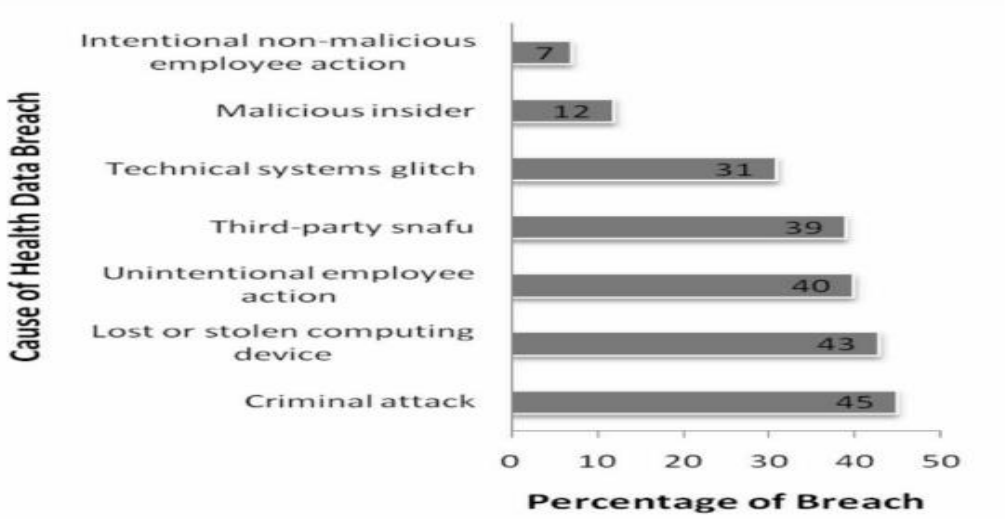

Figure 6 Major reasons of medical data breach in healthcare(Khan and Hoque, 2018)

As stated by Seh, the escalating magnitude and frequency of healthcare data breaches is a significant problem. The article gives an overview of the several sorts of medical data breaches,

covering insider attacks and external attacks, and examines some of the common strategies hackers use to acquire medical data. The ethical and legal consequences of healthcare data breaches are specified in the article, which includes the potential legal consequences on healthcare providers and the impact on patient confidence in the public health system. The monetary consequences of data breaches, such as the price of recovery, legal fees, and reputational harm are also included in it (Seh *et al.*, 2020b).

2.8 BLOCKCHAIN TECHNOLOGY CAN BE USEFUL TO PREVENT FALSIFIED DRUGS AND MEDICAL DATA BREACHES IN INDIAN HOSPITALS

According to Adsul, a drug's entire path from one entity to another can be tracked with the help of blockchain technology. The blockchain stores a record of every transaction involving the drug, making it simple to track the drug and spot falsified drugs. There are two severe issues that blockchain can help, firstly, it can help both pharmaceutical companies as well as the healthcare system to trace the drugs in the supply chain, thereby sealing a circuit that is resistant to counterfeit drugs. Secondly, it can identify the exact site of the drug. The pharmaceutical industry can make absolutely sure that the medications it produces as well as distribute are genuine and safe to consumers through utilizing the immutability and transparency of the blockchain. The technology has the ability to radically change the health sector, improve health outcomes and enhance the experience for patients.(Adsul and Kosbatwar, 2020) Blockchain prevent the falsified drugs by creating a transparent as well as tamper proof record of drug from the manufacturer to the patients. Each medication may be provided a unique identification that is stored in the blocks of blockchain. The unique identifier includes manufacturer, batch number and other important details regarding the drug. This identifier helps for prevent the entering falsified drugs.

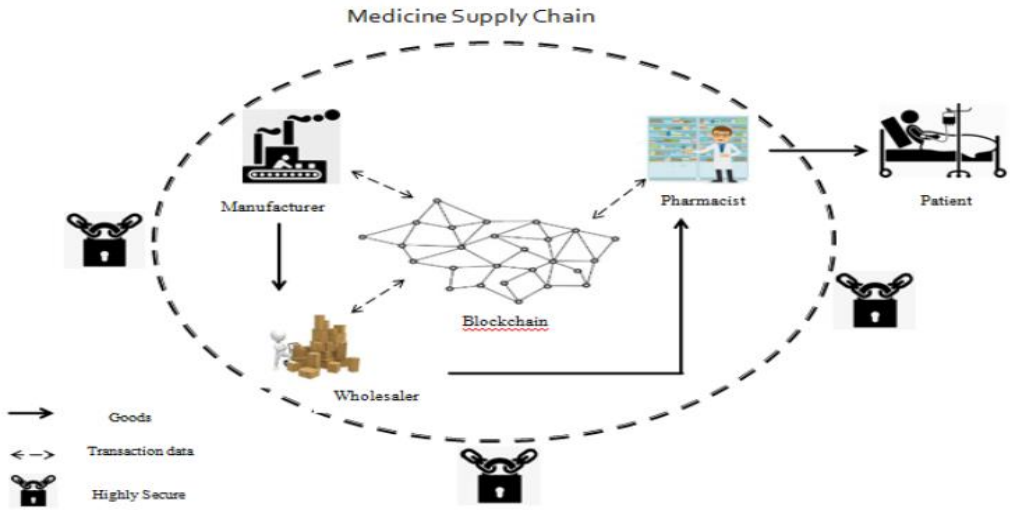

Figure 7 System Architecture of blockchain (Adsul and Kosbatwar, 2020)

According to Uddin, the authors emphasize that blockchain-based drug tracking can benefit all stakeholders involved in the drug supply chain, such as producers, distributors, regulators, and patient, this can improve efficiency in the supply chain, reduce the likelihood of drug counterfeiting, increase accountability and transparency enhance drug security. Two blockchain-based architectures are presented in the article. The two blockchain platforms are Hyperledger Fabric and Hyperledger Besu, the proposed designs are built to offer a better trustworthiness, decentralization, visibility, confidentiality, protection, integrity of data, scalability, adaptability. Depending on the specific requirements of the use cases, both Hyperledger Fabric and Hyperledger Besu can be employed for applications of drug tracking. The fabric would be more suited for complex supply chain management applications which demand for control and privacy. Besu, on the other hand, can be more suitable for cases that demand interoperability with existing Ethereum-based platforms (Uddin *et al.*, 2021).

According to Haq, the company will generate a unique hash and assign it to every product or medicine that it is produced. The item hash the item's hash can be utilized to record it on a blockchain (unique ID). the product will be regarded as a digital asset on the blockchain, its hash can be used to trace it. Based upon the manufacture’s preference any additional information of the product can be stored either on-chain or off chain (Haq and Muselemu, 2018).

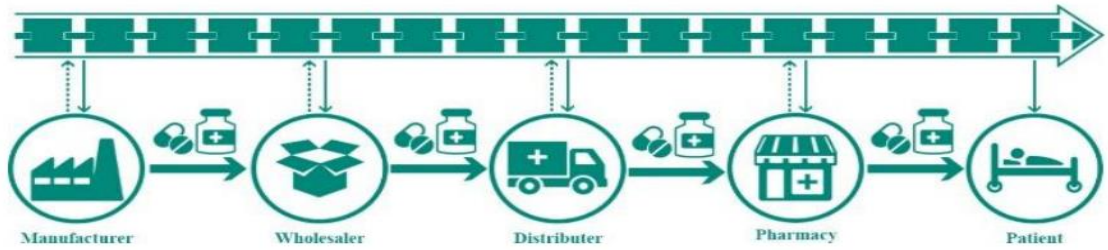

Figure 8 shows the blockchain technology (Haq and Muselemu, 2018)

As stated by Bell, Drug tracking can be carried out by using the immutability of the blockchain to offer a good supply chain from the manufacturer to the customer, preventing pharmaceutical theft and fraud. One such technology is Discover, a product created by Chronicled, which builds a framework for monitoring a drug's journey from production to distribution to patients. Blockchain technology allows health professionals to satisfy medicine supply security requirements while making sure interoperability among providers. A Counterfeit Medications Project was started by Hyperledger, an open-source blockchain working group, to solve the issue of counterfeit medications by identifying their origins using the blockchain and eliminating them from the supply chain (Bell *et al.*, 2018a).

When medical data is used, accessed or revealed without the consent or authorisation it is known a medical data breach which include personal health information, results of the test, prescription and other delicate information and other health related data. Blockchain can prevent the medical data breaches in the healthcare sector by the unique features of blockchain. Patient medical data security has become a major issue as a result of technology advancement in the healthcare sector. Health record absences, improper management, and data issues related to privacy and security all are significant issues in healthcare industry. Even the information currently available is fragmented as well as isolated. Blockchain technology offers enormous potential. Firstly, the decentralized system which differentiates blockchain ensures the reliability of the information throughout the system. The blockchain gives benefits like privacy, confidentiality, as well as integrity of the information without third party interference. Such ability makes this a reasonable choice to store medical data about patients. Researchers have also determined that using blockchain technology in the healthcare industry would be a workable approach (Saha *et al.*, 2019).

As per Doreen, the handling of the patient's large amounts of data can be much more difficult. This medical data is gathered from an array of people, and it can be accessed or changed for significant purposes by a variety of users. The traditional health system exhibits poor security as well as privacy safeguards that are vulnerable to harmful attacks. Nevertheless, these convention techniques have more computational complexity and delay. Because of critical importance of medical data, patient information should be managed with privacy, reliability, and safety. Secured as well as improved encryption schemes therefore are essential in healthcare applications. Thus the, the most current application of distributed ledger technology is considered for such accessibility of all data management, transaction, and storage. The Lionized Golden Eagle Lionized Golden Eagle based Homomorphic Elapid Security (LGE-HES) (fig9) algorithm is suggested for blockchain safety in healthcare systems. The LGE serves for the purpose of selecting the optimal keys as well as detecting cyber-attacks, whereas HES is employed for decryption and encryption. The best private as well as public keys are selected for the transmission and reception. Then the images as well as data are encrypted and uploaded in cloud. Then the private key is employed for decryption (Doreen *et al.*, 2022).

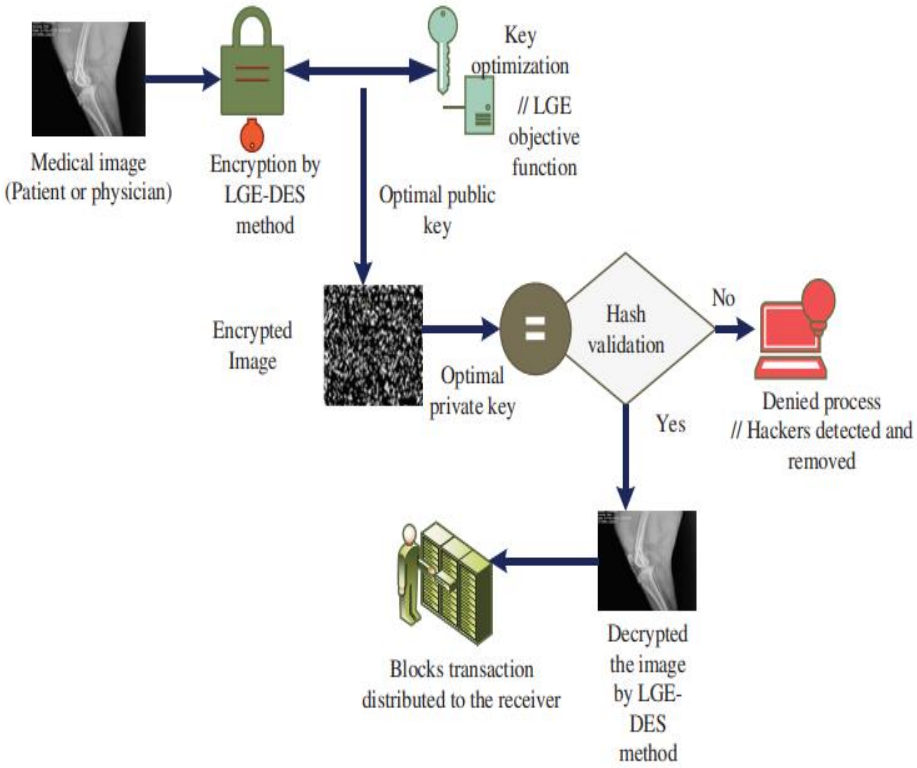

Figure 9 Blockchain technology for healthcare system (Doreen et al., 2022)

Yue proposed an application architecture based on blockchain, which is known as Healthcare Data Gateway (HGD). This application enables patients to freely access, manage as well as share their own records or data. It provides a feasible option for improving the intelligence in medical; systems without compromising patient privacy or security of data.(Yue *et al.*, 2016).Griggs proposed that, a private blockchain which has an Ethereum protocol helps to secure as well as maintain the safe use of sensing devices and they aid to avoid the security problems such as cyber hacking in remote monitoring of patients. Blockchain give security to the medical data by using a consensus mechanism. In this a mechanism agreement from the nodes is required for the addition or deletion of blocks to the chain. A secure real time monitoring is made possible by the blockchain, which enable the doctors to keep a record of their patient health records remotely and can preserve the secure patient history. Privacy as well as authenticity are essential in-patient data history, so blockchain technology utilise the property of distributed ledger for maintaining authenticity and variability. In contrast to a public blockchain only authorised persons can access the data in blockchain verification as well as inspection of a block (Griggs *et al.*, 2018).

According to Shahnaz, Electronic health records (EHRs) can be kept and administered safely & securely through blockchain technology. EHR can store a person's health history, diagnosis, treatments, and other relevant data, it is a crucial component of healthcare systems. Conventional EHR systems, however, have a number of drawbacks, such as privacy concerns, data breaches, and a lack of integration. Blockchain technology provides a decentralized and secure system for storing and exchanging EHRs. Blockchain technology employs a distributed ledger that safely and transparently records transactions. Blockchain is a perfect choice for EHRs since it employs cryptography to assure the data's integrity and confidentiality. The use of blockchain for EHRs has a variety of benefits, among them is giving patients total control over their medical information. Individuals get the choice of allowing or revoking access to the EHRs very time for health care providers, researchers, or even other approved parties. It increases privacy and gives patients greater choice of the treatment. Everyone involved with the supply chain for pharmaceuticals can store key essential data on a blockchain network, where everybody has access to this sensitive and confidential data. Potential participants might be reluctant to become part of these kinds of networks as doing so might end in their losing their competitive advantage, everyone involved with the supply chain for pharmaceuticals can store key essential data on a blockchain network, where everybody has access to this sensitive and confidential data. Potential participants might be reluctant to

become part of these kinds of networks as doing so might end in their losing their competitive advantage, (Shahnaz *et al.*, 2019).

As specified by Xia ,MeDShare is a proposal to confront a few of the problems with medical data sharing which are presently being confronted, such as the lack of interoperability among electronic medical records, the complexity in maintaining patient confidentiality and safety, as well as the increased price of establishing and maintaining a centralized information sharing system. The study shows MeDShare, a blockchain-based solution that enables cloud service providers can exchange medical information without the need of central authority. MeDShare streamlines data sharing among healthcare professionals while protecting patient confidentiality by employing smart contracts. The authors additionally propose a Proof of Stake (PoS)-based consensus method to assure the blockchain's security and integrity (Xia *et al.*, 2017).Liu proposed Blockchain based privacy preserving data sharing ,which combines Electronic medical records. This application used Ethereum blockchain platform ,that lowers the risk of medical information theft as well as secures sharing data in the healthcare sector (Liu *et al.*, 2018).

2.9 CHALLENGES IN IMPLEMENTING THE BLOCKCHAIN IN HOSPITALS

Blockchain technology has the ability to revolutionize the healthcare sector by enhancing data protection, transparency, as well as clinical outcomes. Nevertheless, various barriers must be addressed until blockchain may be implemented fully in hospitals.

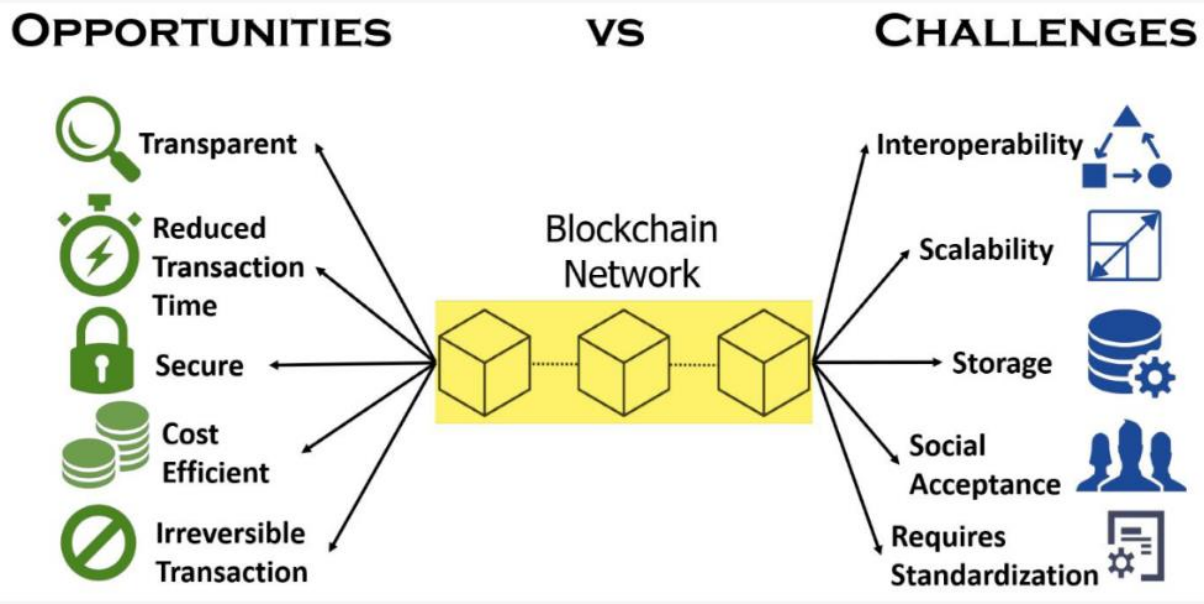

Figure 10 Challenges and Opportunities of blockchain (Siyal et al.*, 2019b)*

According to Botene, blockchain throughput is lesser when compared to traditional centralized databases, this technology is likely to suffer from a lack of scalability. Another barrier is the merging with legal concerns and privacy of data. Transparency as well as decentralised storing of data can have a significant impact on the privacy of the data. The processing of data, storage and presentation methods should comply with the privacy rules. Blockchain technology may be poses some security risks because the information is accessible to everyone in the network node, in some circumstances decentralisation renders the network extremely fault tolerant, which is a serious problem because the technology may be vulnerable to hacker attacks. A poorly developed or terribly presented smart contract could have poor efficiency, low security as well as high execution transaction rate. System operating expenditures are still expensive, as well as a significant amount of information storage capacity is essential. Furthermore, many networks require fees for energy in order to operate their services. It is difficult to predict the expenses associated with implementation. Another challenge is the reluctance to change because lack of awareness about blockchain and its benefits as a technology and there is also a shortage of qualified people (Botene *et al.*, 2021).

According to Dutta, described the organizational, technical and operational challenges in the adoption of blockchain. A handful of technical issues that typically occur while operating blockchain-based distribution networks. Technical challenges can include concerns with system integration, data standards, scalability, and security. Blockchain is considered to be a tamper proofed data storage architecture as well as the most trusted transaction platform but the block size in the blockchain could be a restricting aspect in terms of efficiency and speed of the platform. Chain limitation arising by an ever-increasing volume of transaction, long response time, hefty fees are the major scalability problem in blockchain adoption. A technological issue that may be arise is scalability (Siyal *et al.*, 2019b). When blockchain networks increase and far more operations are processed, its system could require to expand the network to accommodate increased demand. It may be challenging because blockchain systems demand a lot of computer power. Another technical challenge related to the security. Even though blockchain network is usually protected by cryptographic algorithms, privacy of the data as well as confidentiality are a major high issue especially in the case of public blockchain, which keep information and private details as a public ledger (Dutta et al., 2020),).

(Uddin *et al.*, 2021),introducing blockchain technology into operation necessitates huge expenditure in hardware, software, and networking. High expenses associated with

implementation could pose a hurdle for pharmaceutical organizations, especially small and medium-sized firms and hospitals. Moreover, there could be recurring costs involved in sustaining and improving the blockchain system. Another challenge is the lack of standardised rules(Uddin *et al.*, 2021).As per McGhin ,decentralised storage is the essential feature of blockchain, as it enables the user to share information between many services without a centrally controlled provider .The major downside of the decentralised system is the risk of privacy leakage (McGhin *et al.*, 2019).

According to Siyal, blockchain technology remains in its development thus regulatory problems or standardisation challenges can occur. On a Daily basis, a considerable amount of information is processed in the healthcare industry. All of the information, comprising health records, lab tests, Magnetic resonance imaging, and other medical data, would be accessible to every chain node in the blockchain, it necessitated a considerable amount of space for storage. Furthermore, blockchain applications are transaction-based, and the data utilized to support this technology have a potential to develop dramatically. The speed of data searching and accessing slows when databases expand, rendering it extremely inappropriate for the types of transactions where pace is crucial (Siyal *et al.*, 2019b).

As stated by Ratta ,healthcare interoperability is the main barrier in the implementation of blockchain because numerous and different providers as well as its open nature. There is still a slight delay while confirming every block in the blockchain. Furthermore, sustaining each nodes security is the biggest issue. Ownership and accountability of the data is another prime challenge in the implementation of blockchain in healthcare because there are many concerns regarding the ownership, storage as well as authorisation of medical data. Apart from that, many patients could be apprehensive about sharing their health records to third-party organizations in the public domain. As a result, it's indeed critical to build confidence and trust in patients about the confidentiality and safety aspects of the whole health care system, which is enabled by Blockchain and IoT (Ratta *et al.*, 2021).

CONCLUSION

This study mainly concentrates on the consequences of falsified drugs and medical data hacking. Moreover, it focusses mainly on the challenges as well as how the technology help to prevent the medical data hacking and falsified drugs in Indian healthcare. The implementation of blockchain is at the initial stage, more time is required to excel its potential in various fields

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The research methodology is an important section of any dissertation as it gives justification as well as validation for the entire study. This chapter delves into the research techniques, approach, and theory used to evaluate the usefulness of blockchain in preventing falsified drugs as well as medical data breaches in the healthcare sector. In order to effectively critique the hypothesis of the study and meet research objectives, this section analyses the methodology employed for data collection and data analysis. Research onion is employed for the data collection methods (Saunders *et al.*, 2007).

3.2 RESEARCH PHILOSOPHY

Research philosophy is referred as a collection of assumptions as well as attitudes on the advancement of knowledge. Ontology as well as epistemology are employed to interpret research philosophy. There are many Philosophical approaches they are

Interpretivism enables the interpretations of the data in the light of their knowledge gained through the experience as well as their own values. The interpretivism philosophy is focused on integrating the attention of the viewers into the research study because it emphasizes the notion such as communication and sharing of ideas are employed to build and convey reality. The approach analysis is unique and the results provide the context-specific explanation of the observations. This methodology is inherently subjective, personal bias of the researcher will influence the result of the study is the main problem of the approach. Even though, the primary data is trustworthy, this philosophical perspective can generate correct data.

Positivism is the study methodology that takes into account the social reality. The study findings should be compatible with the laws regarding the subject or the theoretical prescriptions. This philosophy is mostly employed in quantitative research. This philosophy helps to connect a current hypothetical situation in relation to the real situation (Goddard and Melville, 2004).

Realism is the study methodology which researcher depend on their optimism or feeling. Even though realism is subtype of positivism but this philosophy is entirely different from

positivism. Realism is mainly employed in quantitative studies such as survey (Buchanan and Bryman, 2009).

Pragmatism -In this methodology, several varieties of methods are employed to conduct the investigation. This research philosophy employs numerous methodologies and minimal influence of philosophy on this approach. This is the subtype of interpretivism (Snyder, 2019).

The research study employs positivism because data are collected by experiences as well as observations. Furthermore, the research study mainly concentrates on the deductive method.

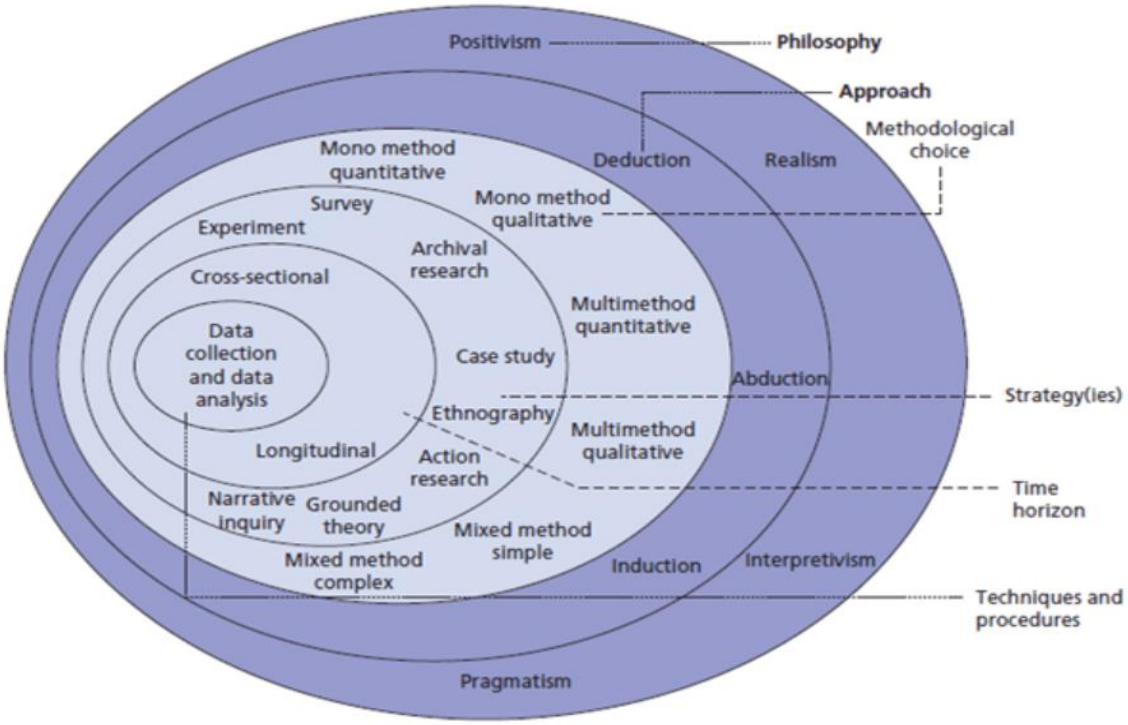

Figure 11 showing the Research onion (Saunders et al., 2007)

3.3 RESEARCH APPROACH

The research approach is the overall approach that the researcher employs in their study. The research approach mainly relies on the type of research question, accessible data, and the researcher's conceptual perspective. It plays a vital role in the research as well as in analyzing the results. There are inductive as well as deductive approaches in research (Teherani *et al.*, 2015).

Deductive approach is also referred as top-down method because it uses a centralized method to find out the relation between the data. In this approach, initially, the concept is supported by the assessment of statistical data. Findings gathered from the data can confirm or disapprove the hypothesis (Gallaire *et al.*, 1989).

Inductive approach is also referred as inductive reasoning, it employs a bottom-up method. This method is based on the findings of the study to determine the hypothesis. Rather than focusing on generalization, it concentrates more on the framework, which enables the researchers to comprehend the theory (Thomas, 2014).

This study uses the deductive approach because positivism is used in the analysis. This approach helps to develop a new stage in the research study or in the investigation. A deductive approach is employed to find out the potential of blockchain to prevent data hacking as well as fake drugs. The main goal of the study is to evaluate the effectiveness of blockchain technology in Indian hospitals and its potential to prevent the issues. So, the deductive approach is the suitable method because the research objectives can only be answered by monitoring as well as analyzing the data collected from the primary research.

3.4 DESIGN OF PRIMARY RESEARCH

The research design details about the way in which the procedure of the study will be conducted. It comprises data analysis, sampling method and suitable technique for the research study. There are 3 categories of research design explanatory, descriptive as well as exploratory design. The research suggests to carry out the descriptive study to help in the generation of response to the questions associated with the topic of the research study. Rather than giving conclusive solutions to the questions, the descriptive research intends to explore into the topic at a deeper depth. Hence, descriptive study has been described as the preliminary study, that helps to prepare the groundwork for further in-depth research. This study seems to be beneficial for the study design as well as data collection. The research employs a quantitative research strategy.

The major goal of the study is to highlight the problem of counterfeit drugs and data hacking in the healthcare industry. The research location chosen for the research is India, therefore the data for the study is acquired by a questionnaire survey. The study will be done among healthcare professionals working in Indian hospitals. The participants of the study are categorized into two types: healthcare professionals who are familiar with blockchain

technology and those who are not. The questionnaire is prepared in such a way that it collects enough data to meet the study goals. The questionnaire will include both open-ended and closed-ended questions to convey the opinion of the respondents about the topic. The data is gathered by using a survey with predetermined choices as well as an area for respondents to provide their own views and forwarded to professionals working in Indian hospitals by means of LinkedIn and other accepted platform. Data gathering with Google forms provides numerous benefits, including simple access, ease of creation and ease of analyzing information, immediate response monitoring, as well as security of the data.

3.5 CHOICE OF THE RESEARCH

The research choice used in the study is the mono-method research because the researcher is using only one research method (survey) to gather as well as analyses the data. In this research study quantitative research method is employed to evaluate the potential of blockchain in preventing fake drugs as well as medical data breaches in Indian healthcare. The data is collected from the healthcare care professionals (McCusker and Gunaydin, 2015).

3.6 SAMPLE SIZE

Sample size in research refers to the number of respondents in the research. In this research study, the data were collected from healthcare professionals such as doctors, and pharmacists.130 respondents were chosen for the survey. The sample size for this survey was calculated with the help of survey monkey. Inclusion criteria for the research study is the healthcare professionals who are working in private Indian hospitals and have more than one year of experience. Exclusion criteria is the healthcare professional working in the northern part of India.

3.7 DATA COLLECTION

The key focus of the research study is the data collection, that can be quantitative study or qualitative study.(Sapsford and Jupp, 1996) Quantitative approaches entail the collection of quantifiable information Survey are most commonly employed in the quantitative analysis for data collection. In this research study google forms is used to collect data for the research study. Data for the research will be acquired through questionnaires with Indian health care workers. The questionnaire will be sent to healthcare practitioners as well as pharmacists through social

media platforms like LinkedIn or through e mail. The questionnaire includes open-ended and closed-ended questions that may be based on the study's objective.

3.8 DATA ANALYSIS

The process of converting gathered responses into a beneficial as well as comprehensible data analysis information is known as data analysis**.** It is an important step in research methodology.MS Excel can be employed for the data analysis. In-depth, knowledge of data can be obtained by using MS Excel.MS Excel offers a user-friendly platform for data visualization and data analysis. It can handle both numerical as well as categorical data.

3.9 TIME HORIZON

A research time frame can be categorized into two

- **Cross-sectional** data is collected in a short period of time
- **Longitudinal** study enables the researcher to conduct simultaneously as well as repeatedly. This is mostly used in the qualitative study (Saunders *et al.*, 2007)

Cross-sectional technique is employed in the research study. It is utilized when a particular time period has been allocated for the primary data collection. Cross-sectional technique employs a positivist approach.

3.10 VALIDITY OF THE RESEARCH

Validity, as well as reliability, are employed to measure the quality of the study. Validity evaluates the data collected and will completely address the objectives of the research study. The usage of the simple questionnaire in the study research aids to comprehend the impact of blockchain in Indian healthcare for preventing fake drugs and data hacking. Hence retaining the validity of the research, the validity of the study is further increased by limiting the participant pool from the same country (India) (SÜRÜCÜ LMASLAKÇI A, 2000)

3.11 ETHICAL CONSIDERATION

The researcher should follow the ethical guidelines of the study, The most significant and crucial element of every study is its ethical content. Healthcare professionals who have experience in blockchain from India are selected as the participants in the research study. Every participant in this study will receive a comprehensive overview of the study's objectives and

methods, as well as guidance regarding how to complete the Google forms. The researcher would make sure that information such as the data required for the study will not be revealed to others. Information regarding the identification of the participants were not gathered.

3.12 LIMITATION

The major limitation of this research study was the small sample size. Samples were taken only from southern part of India because of the limited time period provided for the completion of the study, most of the questions in the questionnaire were close ended, in order to elicit more data, it could be better to include more open-ended questions in the survey questions.

3.13 RESEARCHE'S CONCEPTUAL FRAMEWORK AND OBJECTIVES

The main objectives of the study are

- To find out the Consequences of fake medicine and medical record hacking in healthcare.
- To evaluate how blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian hospitals.
- To find out the barriers in implementing blockchain in Indian hospitals.

The research study examines, how blockchain technology helps in preventing the falsified medicines and data hacking in the Indian healthcare system. The study also focuses the challenges in implementing the blockchain technology in the healthcare sector. Furthermore, the research will provide a detailed idea about the problems caused by the fake drugs as well as data breaches.

3.14 RESEARCH CONCEPTUAL FRAMEWORK ON THE BASIS OF LITERATURE REVIEW

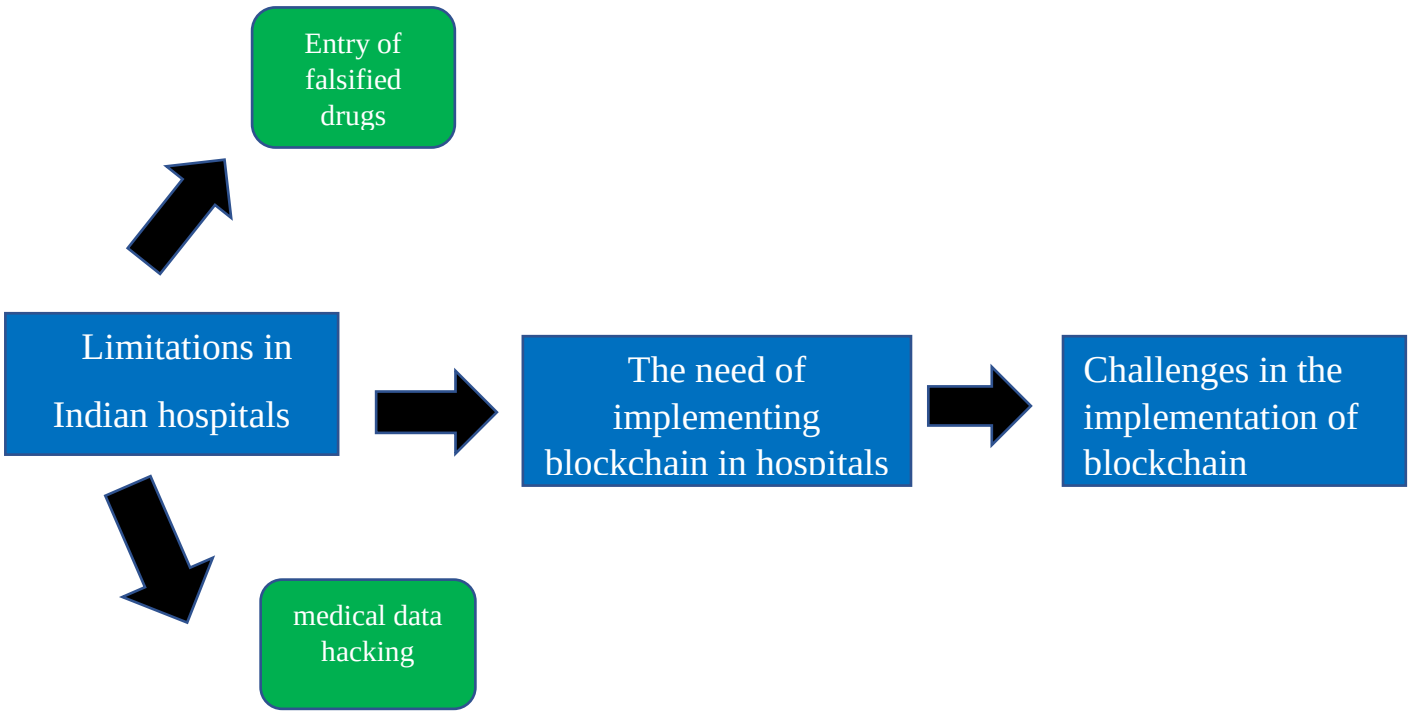

Figure 12 showing the Conceptual frame work of the research

The research will examine how the blockchain can be used in the hospitals in India and as well analyse whether such implementations have been either effective or unsuccessful for preventing data hacking and falsified drugs in healthcare.

3.15 CONCLUSION

The research methodology is an important section of dissertation as it gives justification as well as validation for the entire study The positivism is the research philosophy employed in the study. The data analysis is carried out in this research study by using MS Excel and it is a user-friendly platform for the visualisation of data gathered from the primary research. The questions in the survey are framed according to the goal as well as objectives of the research study. In order to evaluate the potential of blockchain as well as consequences of data hacking as well as falsified drugs a deductive approach is employed. Based on the cross-sectional

analysis, data are collected at a time specified. The study regarding the potential of blockchain technology in healthcare has recently been stated. To gain a more profound understanding of this novel technology, further extensive research is needed. Blockchain technology needs a strong as well as reliable information technology system in order to work efficiently.

CHAPTER 4

FINDINGS AND ANALYSIS

4.1 INTRODUCTION

This section analyses and interprets the data collected from the primary research. The results from the collected data and literature review are analysed. A quantitative study is employed in this study. The survey was carried out among the healthcare professionals who are working in Indian healthcare.130 participants responded to the given survey form.

4.2 ANALYSIS OF DATA

The questionnaire was sent to the healthcare professionals working in Indian hospitals through emails, and LinkedIn. The survey form was responded by 130 participants. The collected responses were analysed and included in the study. MS Excel was employed for the data analysis. In-depth, knowledge of data can be obtained by using MS Excel.MS Excel offers a user-friendly platform for data visualization and data analysis. It can handle both numerical as well as categorical data.

4.3 EXPERIENCE OF HEALTHCARE PROFESSIONALS IN YEARS

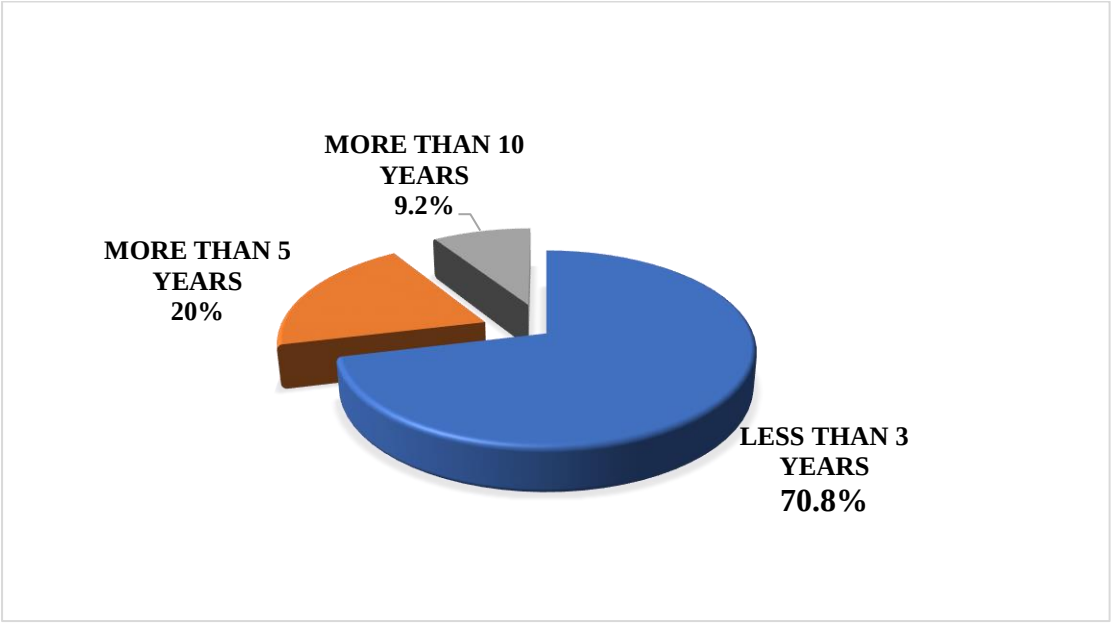

Figure 13 shows the experience of healthcare professionals in years

EXPERIENCE	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Less than 3 years	92	70.8%
More than five years	26	20%
More than 10 years	12	9.2%

Table 1 Experience of healthcare professionals

Among the 130 participants, a significant majority in the survey 70.8 % (92 participants) were having experience of less than three years and 20% (20 respondents) have experience more than five years. Only 9.2% (12 participants) of healthcare professionals have the experience of more than ten years. In light of their knowledge and comprehension of the issue, qualified professionals may provide helpful context for the questionnaire's results. From the results (figure 1), it is evident that the majority of the participants in the survey have less than 3 years. An experienced participant can give more valuable insights as well as perspectives on the issues like data hacking as well as falsified drugs in healthcare.

4.4 AWARENESS OF BLOCKCHAIN IN HEALTHCARE PROFESSIONALS

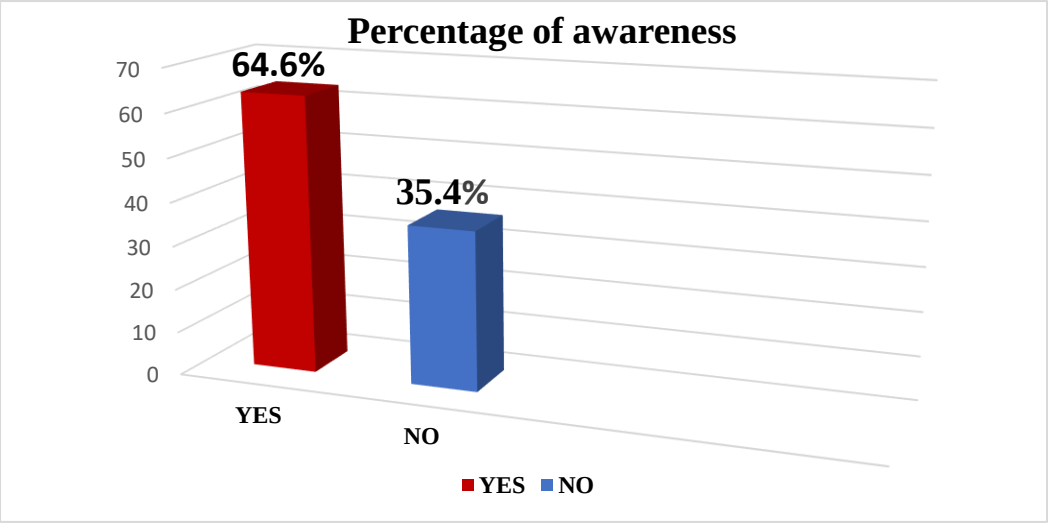

Figure 14 shows the awareness of blockchain technology among healthcare workers

AWARENESS OF BLOCKCHAIN TECHNOLOGY	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Yes	84	64.6%
No	46	35.4%

Table 2 Representing the awareness of blockchain technology among healthcare workers

The second question of the survey aimed to determine the level of awareness of blockchain technology among healthcare workers, such as doctors and pharmacists. The results, shown in Figure 14, indicate that out of the 130 respondents, 64.6% (84 individuals) were aware of blockchain technology and its potential benefits in the healthcare sector. On the other hand, 35.4% (46 participants) reported being unaware of the technology and unfamiliar with its benefits. Overall, the survey suggests that a majority of healthcare workers are aware of blockchain technology and its potential benefits. This finding is reflected in Figure 14, which shows that majority of the respondents agree that blockchain technology has the potential to transform the healthcare sector. It is worth noting that while awareness of the technology is important, it does not necessarily indicate a comprehensive understanding of its complexities or practical applications. However, the fact that a large percentage of healthcare employees are familiar with blockchain technology is an indication that the technology is gaining momentum within the medical field as well as has the potential to be further researched and incorporated into healthcare sector. This question helps to comprehend the extent to which healthcare professionals are educated about this novel technology and its potential applications in the healthcare sector. This question aids to provide useful insights into the degree of education as well as training required to enhance the awareness as well as understanding of blockchain technology in healthcare.

4.5 FALSIFIED DRUGS OR MEDICAL DATA HACKING IN INDIAN HOSPITALS

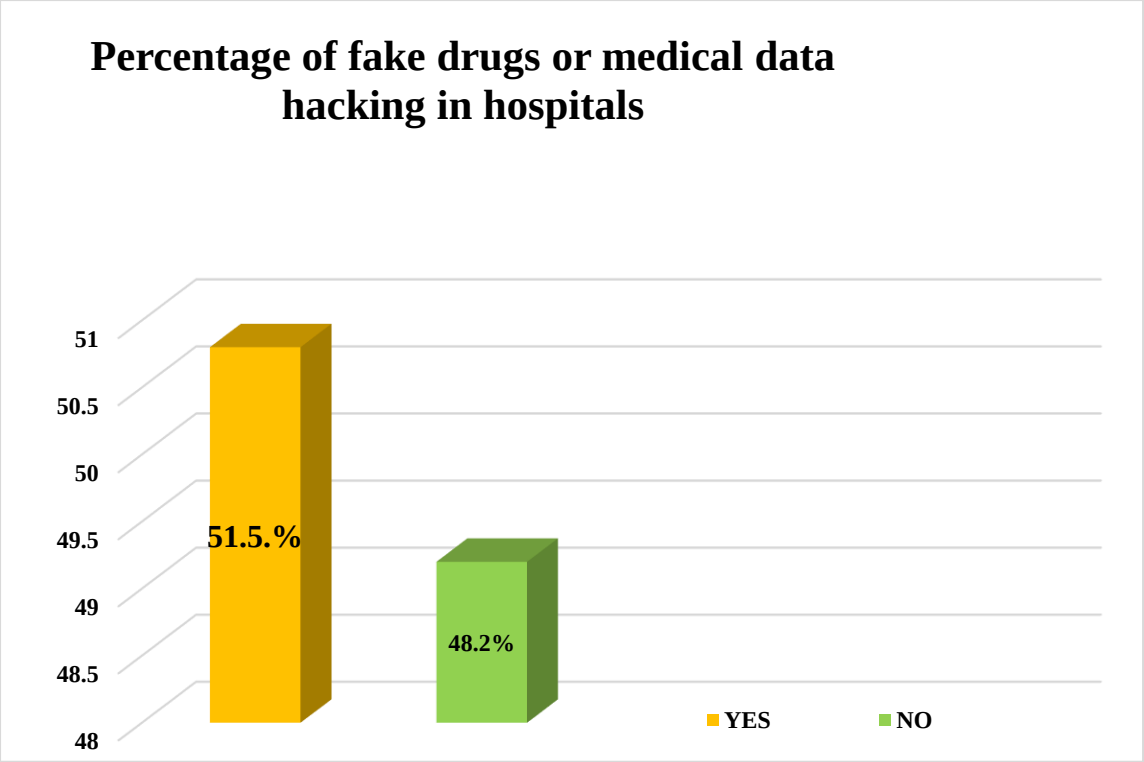

Figure 15 Percentage of people who agreed with the statement that data hacking or medical data breaches take place in hospital

FALSIFIED DRUGS AND DATA HACKING IN HOSPITALS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Yes	63	51.5%
No	67	48.2%

Table 3 shows the healthcare workers agreed with falsified drugs or medical data hacking take place in hospitals

The third question of the survey aimed to determine the prevalence of the percentage of falsified drugs as well as medical data hacking in Indian healthcare. From the results as shown

in figure 15, it is evident that around 51.5% (63) of people agreed with the notion that they had encountered fake drugs or medical data breaches. On the other hand,48.5% (67) disagreed with the statement that they didn't witness any data breaches as well as fake drugs in their hospital. The high percentage of participants who reported falsified drugs or medical data breaches highlights that sufficient measures or technology are required to prevent these problems in the healthcare sector. According to the reports, in India, there were a lot of medical data breaches and fake drugs and necessary steps or technology are needed to prevent these issues. This survey helps the researcher to gain knowledge about the prevalence and impact of these two distinctive but related concerns by asking this question, which can influence attempts to tackle them and enhance safety for patients and quality of care in Indian hospitals.

4.6 CONSEQUENCES OF FALSIFIED DRUGS IN INDIAN HOSPITALS

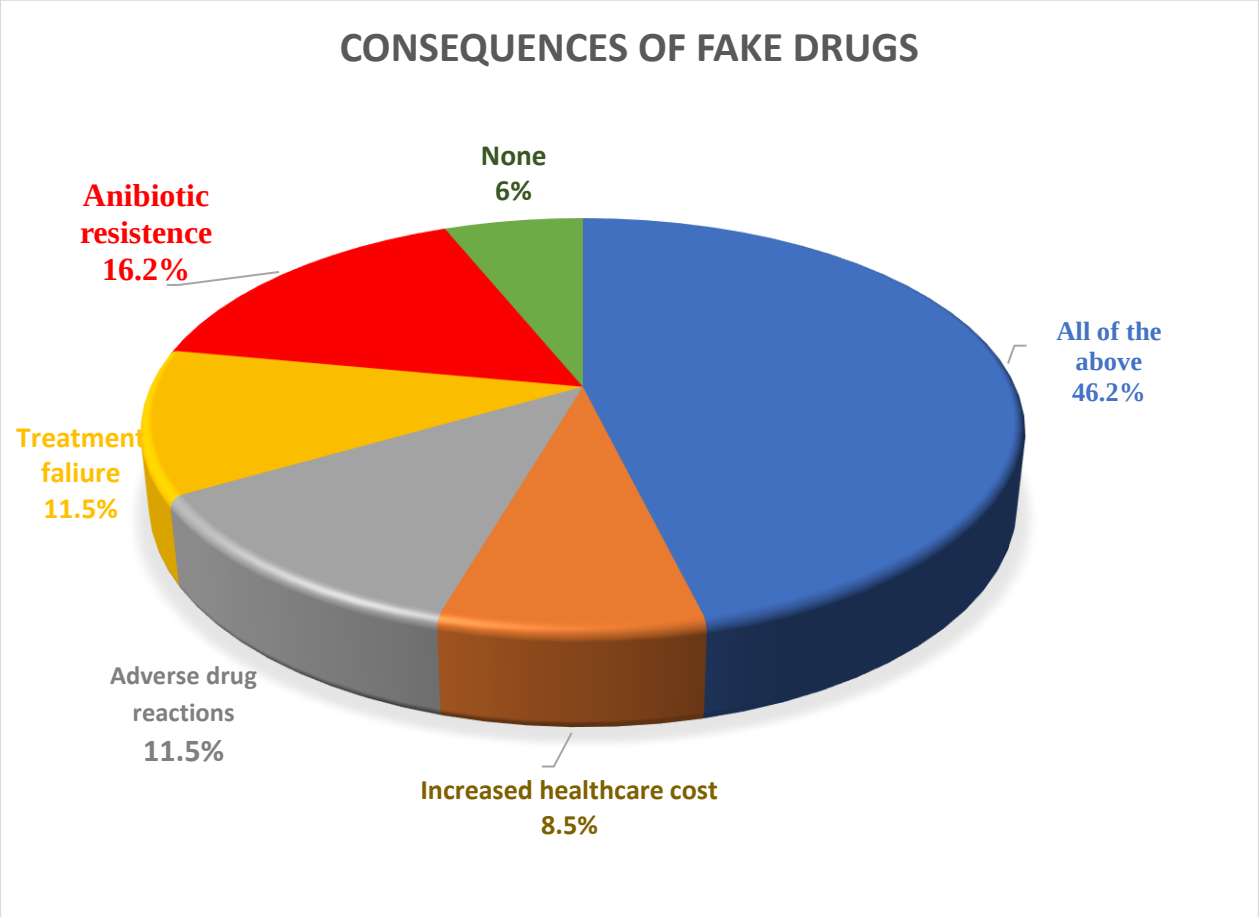

Figure 16 shows the consequences of fake drugs in Indian hospitals

CONSEQUENCES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
All of the above	60	46.2%
Antibiotic resistance	21	16.2%
Adverse drug reaction	15	11.5%
Treatment failure	15	11.5%
Increased healthcare cost	11	8.5%
None	8	6.2%

Table 4 demonstrate the consequences of falsified drugs

In today's scenario entry of falsified drugs is increasing abundantly and there are many consequences faced by the people as well as in the healthcare sector. From the data collected (fig 4) so far, it is clear that the majority of the participants (16.2%) opined that fake drugs cause antibiotic resistance, while 11.5% of the participants said that the fake drugs cause treatment failure, while the other 11.5% claimed that fake drugs cause adverse events in patients. Some think that the use of fake drugs directly contributes to the increased healthcare cost (8.5%), while 16% support all of the above consequences, as a result of fake drug usage, and a very small percentage of the population (6.2%) were not aware of the consequences of the falsified drugs. From the result, it is evident that antibiotic resistance, adverse drug reaction, treatment failure, and increased healthcare cost are the major consequences faced by Indian healthcare due to the entry of falsified drugs. The issue of falsified drugs is comparatively higher in developing countries when compared to developed countries. The extent, as well as the severity of the falsified drug consequences in Indian healthcare, can be understood from this question.

4.7 CONSEQUENCES FACED BY DATA HACKING IN INDIAN HOSPITALS

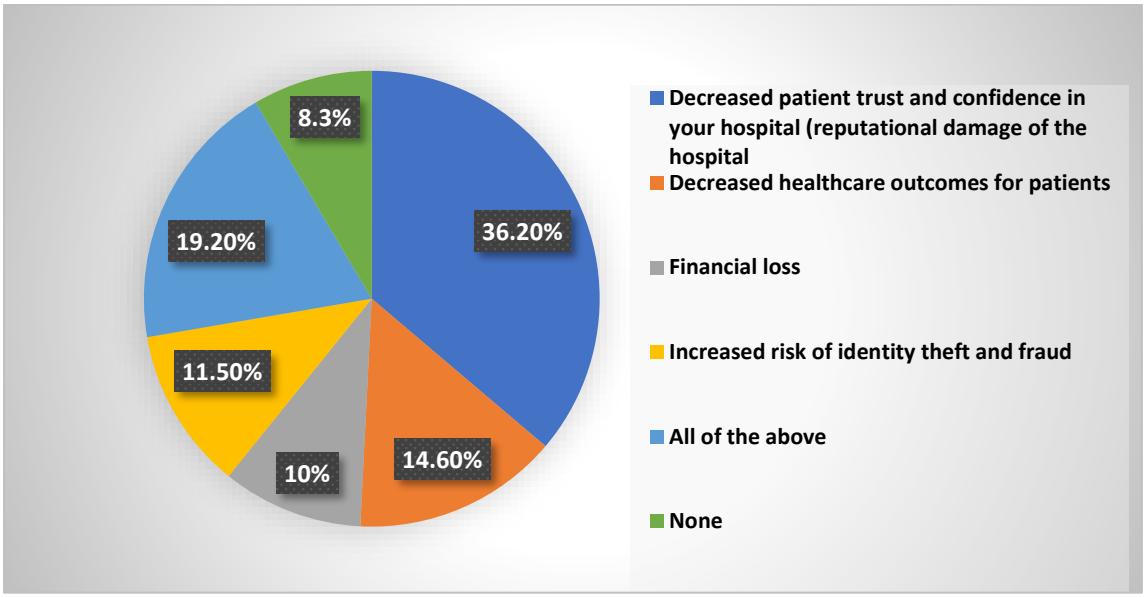

Figure 17 Consequences of medical data hacking in hospitals

CONSEQUENCES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Decreased patient trust and confidence in hospital (reputational damage)	47	36.2%
All of the above	25	19.2%
Decreased healthcare outcomes for the patient	19	14.6%
Increased risk of identity theft and fraud	15	11.5%
Financial loss	13	10%
None	11	8.5%

Table 5 shows the consequences of medical data hacking

The purpose of the question was to collect data about the impact of illegal access to a patient medical data record in Indian healthcare. The results of the research survey indicate that a significant number of respondents (47 out of the total surveyed) agreed that reputational damage to the hospital is the main consequence of medical data hacking in hospitals, representing 36.2% of the total responses. Additionally,14.6% of the participants believed that data hacking can affect the healthcare outcomes of the patient. While about 11.5% of the participants thought that data hacking can increase the risk of identity theft and fraud. Moreover, 10% of the participants also thought that data hacking can be a major source of financial loss for both hospitals and patients. Furthermore, 19.2% of participants thought all of the above can be the consequences of medical data hacking, whereas 8.5% of participants thought that medical data hacking had none of these consequences. On review of the results collected, it shows that reputational damage is a major consequence faced in Indian healthcare which was followed by all other consequences. This question helps to gain a better insight into the scope as well as the magnitude of medical data hacking in the Indian healthcare sector.

4.8 OPINION OF HEALTHCARE PROFESSIONALS ABOUT THE POTENTIAL BLOCKCHAIN TECHNOLOGY FOR PREVENTING FALSIFIED DRUGS AND MEDICAL DATA HACKING

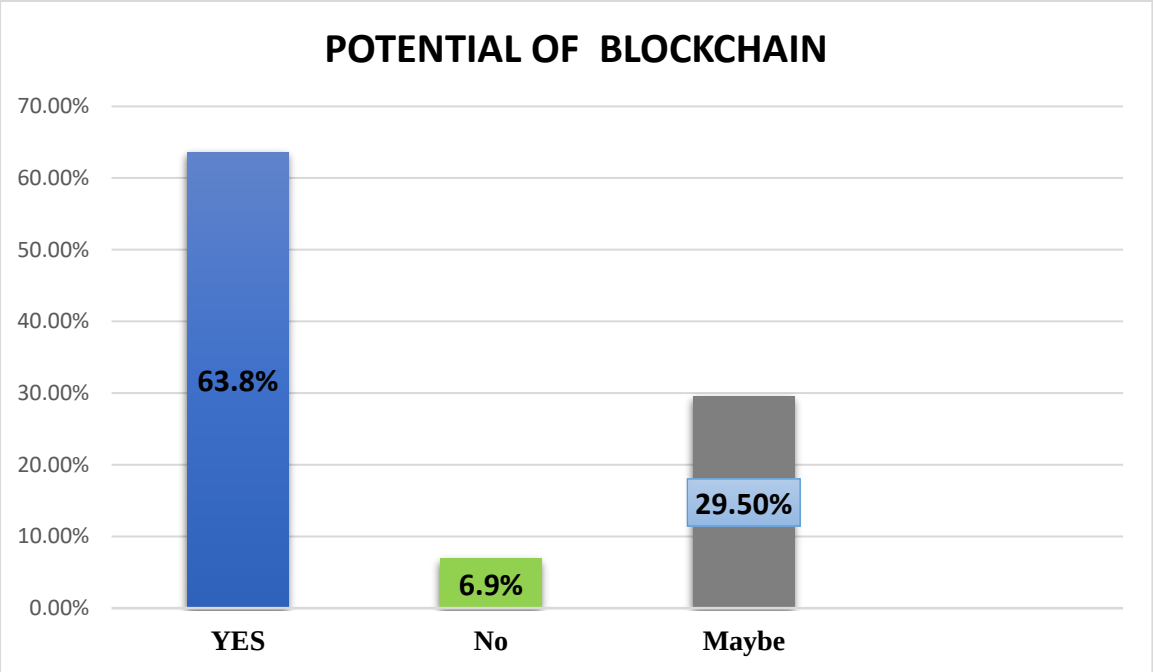

Figure 18 shows the opinion of blockchain technology in preventing the fake drugs and medical data hacking

POTENTIAL OF BLOCKCHAIN	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Yes	83	63.8%
No	9	6.9%
Maybe	38	29.50%

Table 6 shows the opinion of healthcare workers about the potential of blockchain

The participants were asked to share their opinion about using blockchain to prevent drug falsification and data hacking. A majority of participants (63.8%) thought that blockchain has a high potential to prevent both drug falsification and data hacking. However, 29.2% of the participants were not completely convinced by the potential of the blockchain to prevent both drug falsification and data hacking, and 6.9% of participants completely rejected the idea to use blockchain to prevent drug falsification and data hacking. It can be concluded that, from the healthcare workers' point of view, blockchain has the potential to prevent data hacking as well as medical data breaches in Indian healthcare. This question provides an insight into the effectiveness as well as the feasibility of blockchain technology in the healthcare sector.

4.9 HOW CAN BLOCKCHAIN BE HELPFUL IN PREVENTING FAKE MEDICINES IN HOSPITALS?

MECHANISM OF BLOCKCHAIN TECHNOLOGY IN PREVENTING FAKE DRUGS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
By providing a decentralized ledger of drug sales which helps to trace and ensure the integrity of pharmaceuticals	77	59.7%
By keeping a digital record of all medications administered in hospitals	36	27.9%
By enabling physicians to remotely monitor patients' health through wearable gadgets	15	11.6%
Other	1	1%

Table 7 Shows how blockchain helps to prevent the fake drugs

Question was asked to find out the opinion of the healthcare workers about the how blockchain helps in preventing the falsified drugs. Among the 130 responses,59.7 % of people opine that blockchain helps in preventing fake drugs using a decentralised ledger, that will help to track as well as ensure the integrity of pharmaceuticals whereas some healthcare workers believe that the mechanism of preventing falsified drugs is by keeping a digital record of all medication administered in a hospital. 11.6% of participants have the opinion that technology will enable physicians to remotely monitor the patients' health

through wearable gadgets. Only one percent of people have different opinions that blockchain employs smart contract to prevent the falsified drugs in Indian healthcare. From the results, it can be concluded that blockchain prevents data hacking by the distributed ledger which helps to trace and ensure the integrity of pharmaceuticals. This question helps to understand how blockchain helps in preventing the fake drugs in Indian healthcare. Furthermore, it also provides valuable insight into the potential benefit of blockchain technology in the healthcare industry.

4.10 THE KEY ADVANTAGES OF USING BLOCKCHAIN FOR STORING PATIENT MEDICAL RECORDS IN HOSPITALS

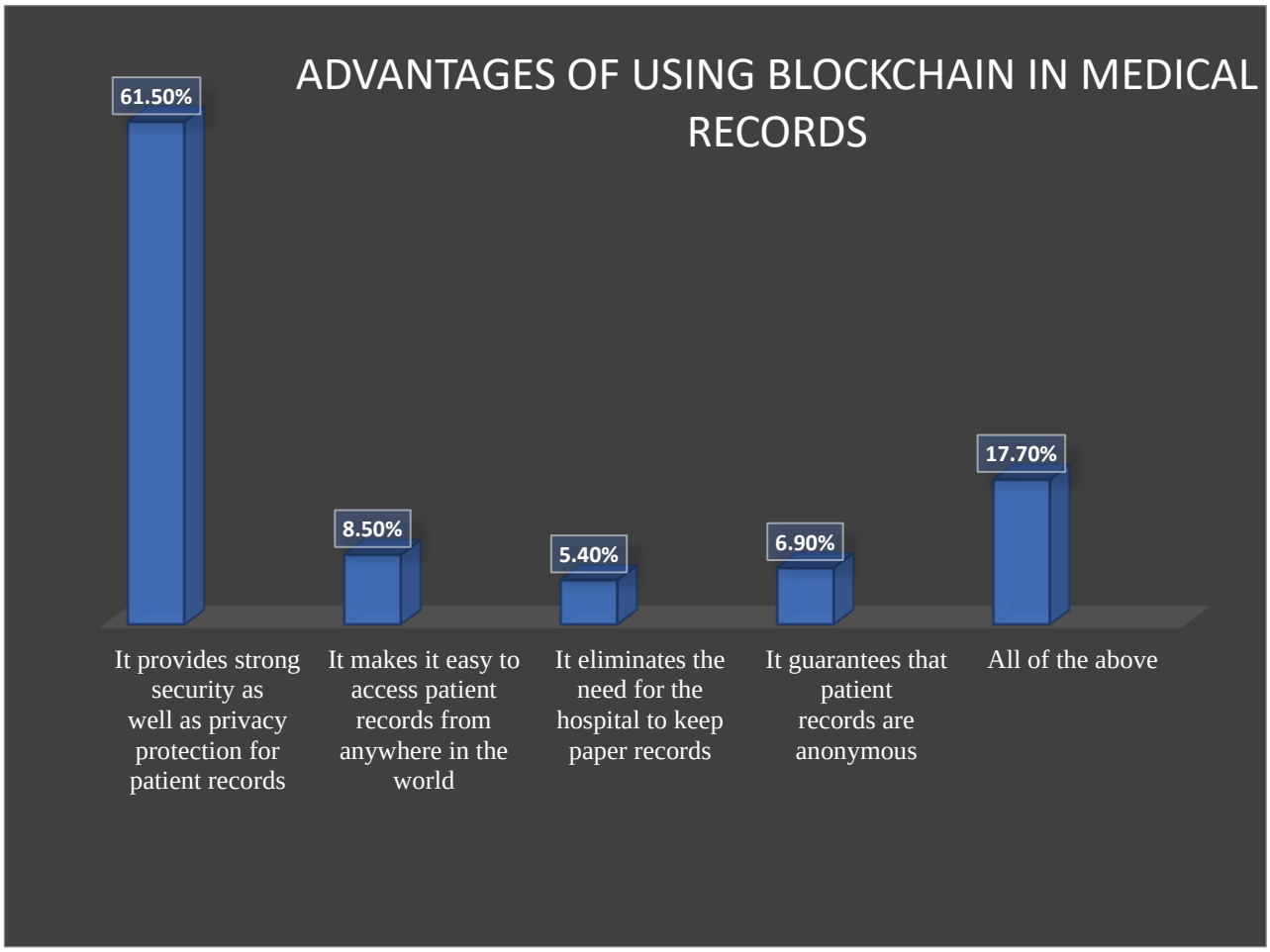

Figure 19 showing the advantages of using blockchain in medical records

ADVANTAGES OF BLOCKCHAIN	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
It provides strong security as well as privacy protection for patient records	79	61.%
It makes it easy to access patient records from anywhere in the world	10	7.8%
It eliminates the need for the hospital to keep paper records	7	5.5%
It guarantees that patient records are anonymous	9	7%
All of the above	23	18%

Table 8 Advantages of using blockchain in using medical records

The next question is to understand the key advantage of blockchain in the case of storing patient medical records in hospitals. Around 79 participants believe that blockchain technology can provide strong security as well as protection of privacy for medical records while 7.8% believe that blockchain technology makes it easy to access patient records from anywhere in the world. Apart from that,5.5% thought that this technology aids to eliminate the need for the healthcare settings to keep paper records and 9 percent strongly support that the technology helps to guarantee the medical records are anonymous. Around 23 participants strongly responded that all of the above is the advantage of blockchain technology. This question helps to comprehend the benefits of using blockchain technology in the case of medical records.

4.11 IN YOUR VIEWPOINT, HOW DOES BLOCKCHAIN IMPROVE THE SECURITY AND PRIVACY OF PATIENT MEDICAL RECORDS IN HOSPITALS?

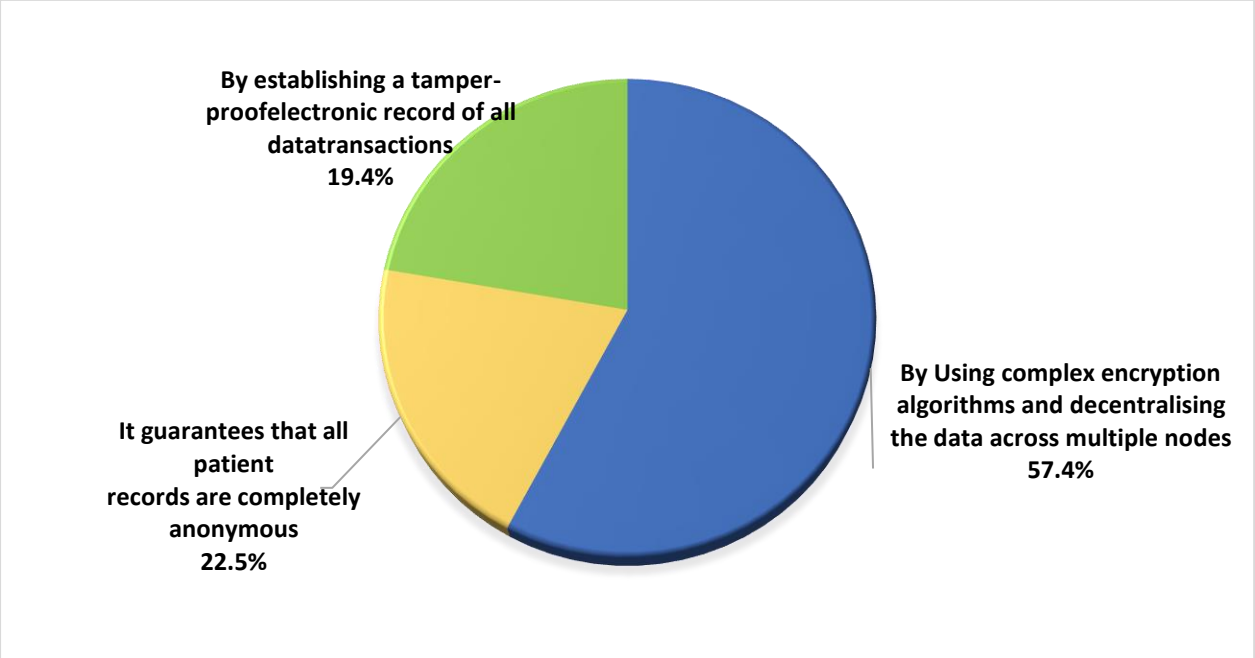

Figure 20 shows the how blockchain technology prevents data hacking based on the viewpoint of healthcare workers

MECHANISM OF BLOCKCHAIN TECHNOLOGY IN MEDICAL DATA HACKING	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
By using complex encryption algorithms and decentralising the data across multiple nodes	74	57.4%
By establishing a tamper-proof electronic record of all transactions	29	22.5%
It guarantees that all patient records are completely anonymous	25	19.4%

Table 9 shows how blockchain technology prevents data hacking based on the view point of healthcare workers

This question was asked to understand how blockchain helps in preventing medical data hacking in Indian healthcare. Around 57.4% believe that blockchain prevents data hacking with the help of complex algorithms and decentralizes the data across multiple nodes and 29 participants support the statement that the technology is establishing a tamper-proof electronic record of all transactions. On the other hand, only 19.4% of people claim that it guarantees that all the records are anonymous. This question helps to gain valuable awareness into the mechanism of blockchain in preventing the medical data hacking.

4.12 CHALLENGES IN THE ADOPTION OF BLOCKCHAIN TECHNOLOGY IN INDIAN HEALTHCARE

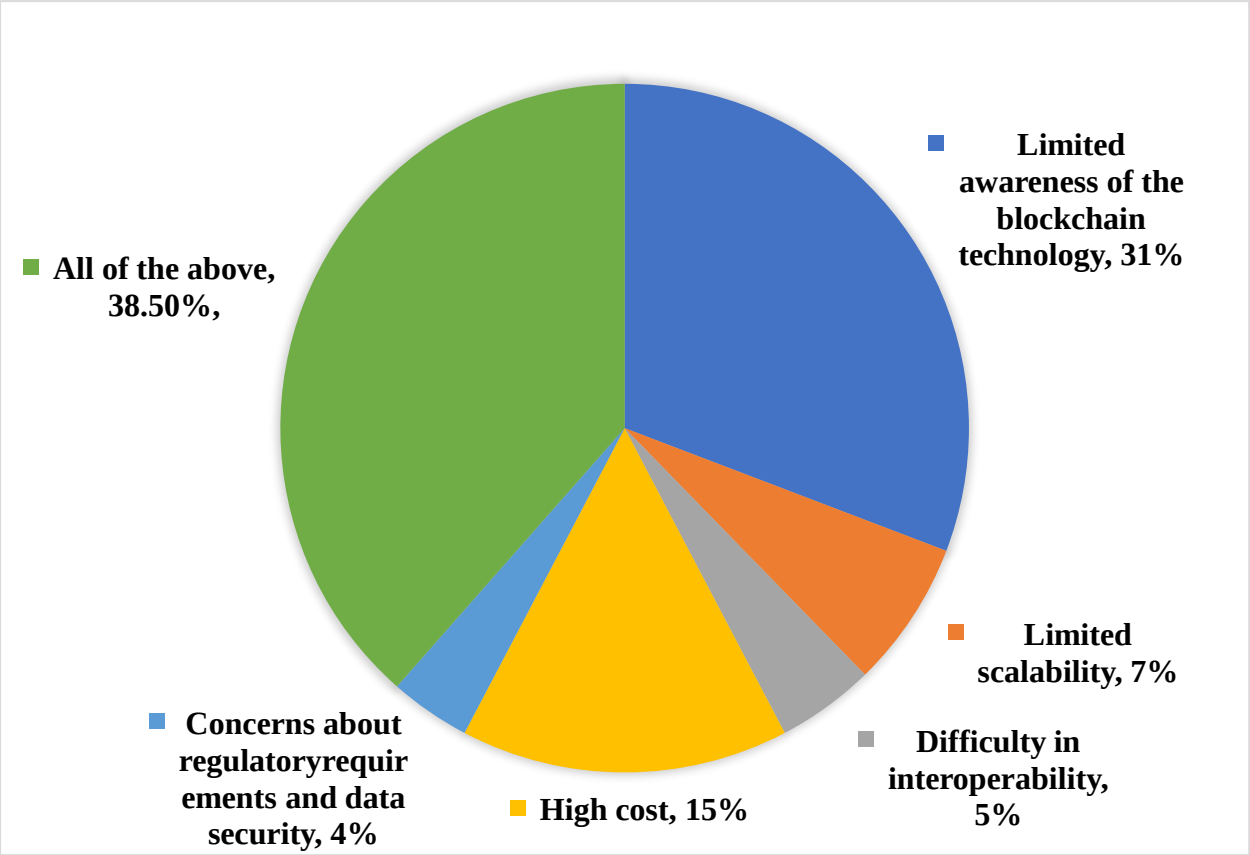

Figure 21 shows the challenges in the adoption of blockchain technology in Indian hospitals

CHALLENGES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
All of the above	50	39.1%
Limited awareness of the blockchain technology	39	30.5%
High cost	20	15.6%
Limited scalability	9	7%
Difficulty in interoperability	5	3.9%
Concerns about regulatory requirements and data security	5	3.9%

Table 10 shows the challenges of blockchain technology

The next question was asked to understand the challenges in the adoption of blockchain technology in Indian hospitals. Based on the given data (figure 21), the most common reason for not adopting blockchain technology is a lack of knowledge or understanding of the technology, with 30.5% of respondents indicating this as the reason. The next most common reason is the high cost, with 15.6% of respondents citing this as a barrier to adoption. Other reasons for not adopting blockchain technology include limited scalability (7%) and 3.9% opine that difficulty in interoperability is the main challenge in the adoption of blockchain technology in Indian healthcare. Around 3.9 % of participants believe that concerns about regulatory requirements and data security as well as interoperability are the major challenges in the adoption of this technology. However, it is worth noting that a significant majority of participants (39.1%) of people opine that "All of the above" are the barriers to adopting blockchain technology in Indian healthcare.

4.13 DO YOU BELIEVE THAT BLOCKCHAIN USE WILL ACCELERATE IN THE FUTURE YEARS AND BRING POSITIVE IMPROVEMENTS TO HEALTHCARE?

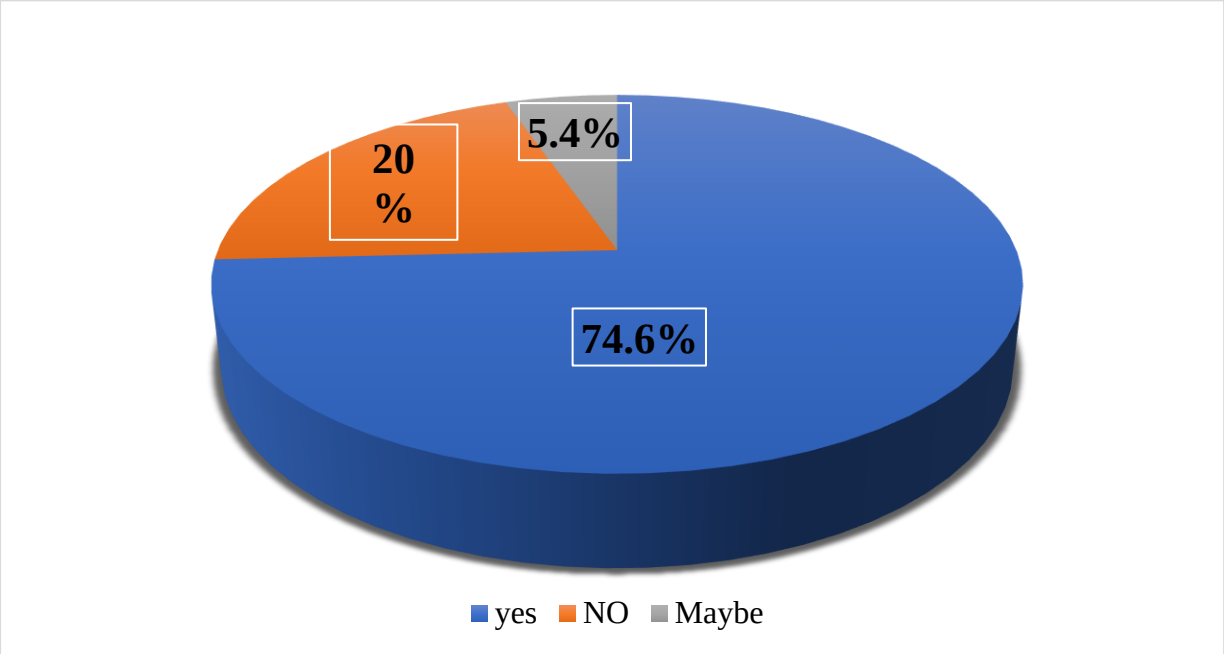

Figure 22 showing the potential advancement of blockchain technology from the healthcare workers point of view

ADVANCEMENT OF BLOCKCHAIN IN FUTURE YEARS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Yes	97	74.6%
No	7	5.4%
Maybe	26	20%

Table 11 showing the potential advancement of blockchain technology from the healthcare workers point of view

From the 130 participants who took part in this survey, 74.6% expressed their belief that the use of blockchain in healthcare will accelerate the improvement in the healthcare sector and can positively impact the healthcare that the patients would receive in the future. While 20% of the participants did not adhere to the idea of blockchain playing a key role in improving health care. At the same time, 5.4% of the participants neither agreed nor disagreed with this concept. This question is to understand whether healthcare workers feel that blockchain technology will bring positive improvements in the healthcare sector.

4.14 DO YOU FAVOUR THE IDEA OF IMPLEMENTING BLOCKCHAIN IN YOUR HOSPITAL?

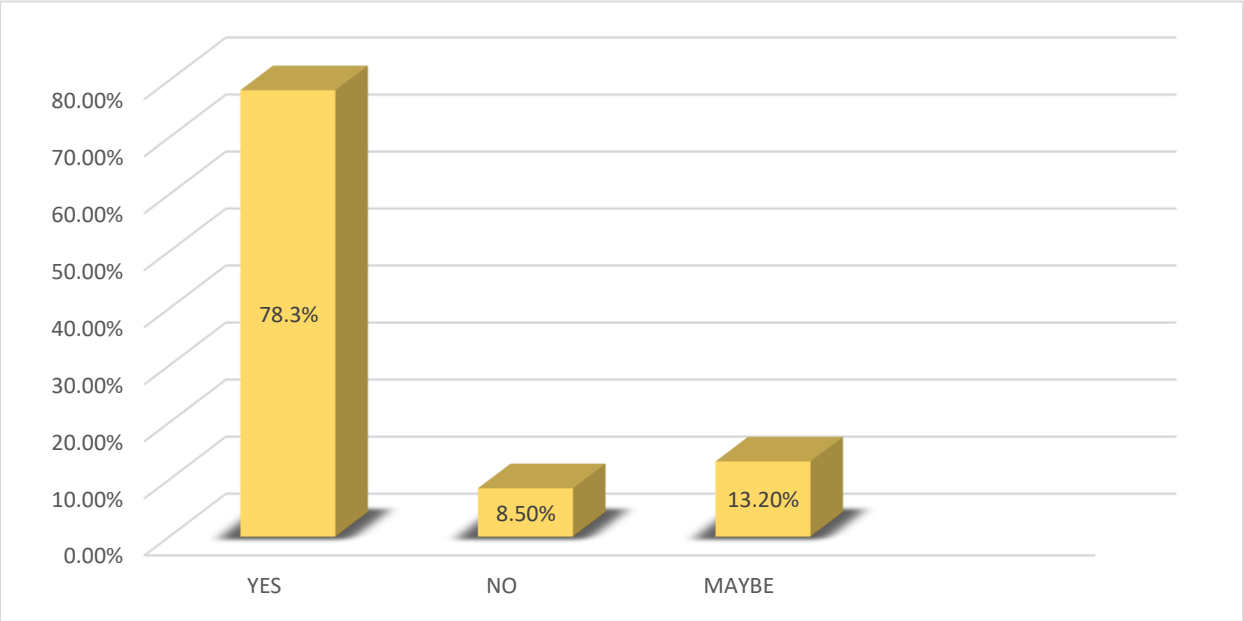

Figure 23 Representing the opinion of healthcare workers about the idea of implementing blockchain in hospital

OPINION ABOUT IMPLEMENTING BLOCKCHAIN IN HOSPITALS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONSE
Yes	101	78.3%
No	11	8.50%

Maybe	17	13.20%

Table 12 shows the opinion of healthcare workers about the idea of implementing blockchain in hospital

The next question asked to know the opinion on adopting blockchain in their hospital because there are many fake drugs and data hacking of medical data is prevalent in Indian healthcare. This question is known about the majority of healthcare professionals' opinions about implementing blockchain in Indian hospitals. Out of 130 healthcare professionals, 78.3% gave a positive response on implementing blockchain in their hospital whereas 13.2% said that they will opt for the option of implementing blockchain because they were unaware of the blockchain technology.8.5% give a neutral opinion about implementing blockchain in their hospital.

4.15 OPINION OF THE HEALTHCARE WORKERS ABOUT THE IMPLEMENTATION OF BLOCKCHAIN TECHNOLOGY IN INDIAN HEALTHCARE

Respondent	**Opinion**
Respondent 1	Worth a try. Prevention of data hacking is a must as it is a core of patients' treatment history. By identifying falsified drugs, we can improve patient health and reduce the rate of any underlying risks.
Respondent 2	It will be a great start in the medical database and help to provide maximum care to the patient
Respondent 3	Awareness must be given and if the cost factors reduce then it can be implemented everywhere and patient security is ensured
Respondent 4	The products can be traced from origin to pharmacy or retailer, helping to prevent falsified and helping manufacturers to locate a recalled product easily.

Respondent 5	Using blockchain in the healthcare industry can help us share patient details among different people and the data cannot be tampered
Respondent 6	Blockchain technology might help in data security thereby helping in research as well
Respondent 7	Data can be secured confidentially and patient-centred. Can be easily accessed by all healthcare workers and service users. Blockchain technology helps in effective medication management
Respondent 8	It would be very useful and ensure the privacy of hospitals and patients
Respondent 9	Its amalgamation into the current process would have a positive impact on the healthcare sector
Respondent 10	Blockchain technology has the power to revolutionize the way information about supply chains as well as patient health records can be stored and retrieved.
Respondent 11	I think it's good but implementation requires time and money
Respondent 12	blockchain will play a vital role in preventing fake drugs in healthcare. The authorities need to encourage the novel technology
Respondent 13	It will be a great start in the medical database and help to provide maximum care to the patient
Respondent 14	Helps to provide quality care, increased the trust of the patient, patient satisfaction
Respondent 15	Should be cost-effective and accurate

Respondent 16	It is a very good initiative to minimize drug falsification
Respondent 17	It would be really helpful to the healthcare department
Respondent 18	From my point of view, it will provide more security of patient data thereby can improve overall healthcare outcome of patient
Respondent 19	The introduction of blockchain in hospitals can improve the security of patient data
Respondent 20	It is a big overview of the privacy of records

Table 13 represents the opinion of healthcare workers on implementing blockchain technology in the healthcare sector

All the participants have positive responses to the implementation of blockchain technology in healthcare. Some people specify that awareness, as well as training, need to be given about blockchain technology. Participants opine that it is a great start to the medical database and drugs can be traced from the manufacturer to the patient. Majority of the healthcare workers believe that blockchain can prevent medical data hacking as well as falsified drugs prevalent in Indian healthcare. Some people commented that blockchain technology has several advantages however implementing the blockchain in the healthcare sector requires money.

ANALYSIS AND DISCUSSIONS

The research aim was to find out the problems caused by falsified drugs and medical data hacking in healthcare and to outline, how blockchain helps in preventing fake drugs and medical data hacking in Indian hospitals. The following objectives were achieved in this research study.

- To find out the Consequences of fake medicine and medical record hacking in healthcare.
- To evaluate how blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian hospitals.
- To find out the Challenges in implementing the blockchain in Indian hospitals.

Blockchain is a distributed, decentralized ledger technology that enables secure, transparent, as well as tamper-proof transactions and record-keeping. In a blockchain network, data is stored in blocks that are linked together in chronological and sequential order, forming a chain of blocks.

4.16 CONSEQUENCES OF FALSIFIED DRUGS IN INDIAN HEALTHCARE

In this research study, the first goal is to find out the consequences of falsified drugs in Indian healthcare around 60 participants believe that, antibiotic resistance, adverse drug reactions, treatment failure, and increased healthcare costs are the major consequences of falsified drugs. One of the significant facts understood from this research is that the rate of fake drugs is increasing day by day. From Figure 4.5 around 51.5 agreed that falsified drugs are prevalent in Indian healthcare. The article entitled" The Menace of fake drugs Consequences, causes and possible solutions "details the consequences of falsified drugs such as therapeutic failure, antibiotic resistance, and increased healthcare (Chika *et al.*, 2011). A similar survey was conducted in Nigeria to find out the consequence of falsified drugs and the result showed that antibiotic resistance is the major consequence of fake drugs (Joda *et al.*, 2017). The article "Substandard and falsified antibiotics neglected drivers of antimicrobial resistance " details that low-income countries have a high prevalence of antibiotic resistance due to falsified drugs (Zabala *et al.*, 2022). Another study was also conducted in Nigeria to find out the consequences of falsified drugs and loss of confidence in the healthcare system, treatment failure, and adverse effect are the major consequences reported in that survey (Aminu and Maikiyo, 2016).

From this research study, it can be concluded that consequences like antibiotic resistance, adverse drug reactions, treatment failure, and increased healthcare costs are the major consequences of fake drugs in Indian healthcare. These findings from survey helps to understand the extent, as well as the severity of the falsified drug consequences in Indian healthcare.

4.17 CONSEQUENCES OF DATA HACKING IN INDIAN HEALTHCARE

The consequences of medical data hacking is clearly explained in the article he specified that reputational damage, financial loss, legal consequences, are the major consequences in healthcare (James Brogan, 2022). From the research survey around 47 agreed that the reputational damage of the hospital is the main consequence of medical data hacking in hospitals (36.2%). These findings highlight the importance of securing medical data in hospitals not only for safeguarding of the privacy as well as security of the medical records but also to maintain the trust as well as confidence in the healthcare system. The article titled" financial consequences of cyberattacks leading to data breaches in the healthcare sector "details about the financial loss of the healthcare system (Meisner, 2017). In the article "Healthcare data breaches ;insight and implications "details about the healthcare data breaches however it didn't clearly detail about the consequences of medical data breaches in healthcare (Seh *et al.*, 2020a).In this research study, the consequences of falsified drugs in the healthcare sector were outlined.

From the data gathered by the survey, it can be concluded that reputational damage is the main consequences faced by the healthcare sector due to data hacking. This survey question aids to attain a better understanding about the magnitude of medical data hacking in the Indian healthcare sector.

4.18 HOW BLOCKCHAIN TECHNOLOGY CAN BE USEFUL TO PREVENT FALSIFIED DRUGS

According to the article, the falsified drugs can be prevented by blockchain technology. The article concluded that the decentralized leger helps to trace the drugs from the manufacturer to the patients. The article "a novel approach for traceability and detection of counterfeit medicines through blockchain" details about how the blockchain helps in preventing the falsified drugs (Adsul and Kosbatwar, 2020)."Application of blockchain within the healthcare" titled article only gave an overview of drug tracking and how the blockchain technology helps in preventing falsified drugs topic were not covered by the article (Bell *et al.*, 2018b). This research study includes how the blockchain helps to prevent falsified drugs. Around 77 respondents believe that blockchain prevent the falsified drugs by using a decentralized ledger of drug sales which helps to trace and ensure the integrity of pharmaceuticals. From the data gathered, it can be concluded that, Blockchain prevent the falsified drugs by using a

decentralised leger. This research provides a valuable insight into the potential benefit of blockchain technology in the healthcare sector.

4.19 HOW BLOCKCHAIN TECHNOLOGY CAN BE USEFUL TO PREVENT MEDICAL DATA BREACHES IN INDIAN HOSPITALS.

Around 79 participants in the survey support to the notion that blockchain prevent the medical data breaches in the healthcare by using complex encryption algorithms and decentralising the data across multiple nodes. Similar study was conducted to find out the mechanism of blockchain technology in preventing the medical data breaches in the healthcare sector. The article and the result obtained was same as the survey results (Yang and Yang, 2017).

The results from survey shows that blockchain technology prevent the medical data hacking by using encryption algorithm as well as decentralising the data across multiple nodes. Around 54.7 healthcare professionals support to the statement.

4.20 CHALLENGES IN IMPLEMENTING THE BLOCKCHAIN IN INDIAN HOSPITALS

This survey discusses about the challenges in implementing blockchain technology in Indian healthcare. Around 50% of participants believe that lack of awareness is the major problem in adopting the blockchain technology in healthcare sector and 50% believe that high cost, limited scalability, difficulty in interoperability, concerns about the regulatory requirements and data security are the major barriers in implementing blockchain technology in healthcare. Similar study was conducted to find out the challenges of blockchain technology in healthcare, the author specified the same consequences in the research study. In this article the author specified social challenges as well as standardisation challenges as an additional barrier (Uddin *et al.*, 2021).Another similar study was conducted to find out the challenges of blockchain in the healthcare sector .The article specified about the challenges like scalability, legal issues ,security risks (Botene *et al.*, 2021) and the author supports that lack of awareness is the major challenges in the adoption of blockchain in India is confronted with a large number of challenges as well as barriers in adopting the blockchain technology in healthcare sector. The primary root cause of these challenges is the lack of awareness about the blockchain technology in people. It can be concluded that, from the figure 10, it is evident that around fifty-nine participants support that lack of awareness is the major barrier in the adoption of blockchain

technology in the healthcare sector. Nevertheless, it is anticipated that, it will advance in the future years by encouraging the awareness as well as educational understanding of the blockchain technology across India.

4.21 CONCLUSION

Most of the healthcare workers believe that blockchain has the potential to prevent the falsified drugs and medical data breaches. Antibiotic resistance and financial loss are the major consequences of falsified drugs and medical data hacking respectively. Blockchain is a novel technology, it has the ability to tackle all the problems in the healthcare. Blockchain is a distributed ledger, which aids to protect and securely record all transactions. It is a decentralized database that is managed by many computers. Every block in the chain has a record of numerous transactions. Furthermore, each block is linked to the preceding block in the chain, which generates a chronological sequence. Lack of awareness is the major barrier in the adoption of blockchain technology in the healthcare sector. Nevertheless, it is expected that, it will advance in the future years by encouraging the awareness as well as the training of blockchain technology.

CHAPTER 5

CONCLUSION

5.1 IMPLICATION OF THE STUDY

The research aim was to find out the problems caused by falsified drugs and medical data hacking in healthcare and to outline, how blockchain helps in preventing fake drugs and medical data hacking in Indian hospitals. The following objectives were achieved in this research study:

- To find out the Consequences of fake medicine and medical record hacking in healthcare.
- To evaluate how blockchain technology can be useful to prevent falsified drugs and medical data breaches in Indian hospitals.
- To find out the Challenges in implementing blockchain in Indian hospitals.

Blockchain is an innovative technology that is used to develop innovative concepts in various sectors, especially in healthcare. It is a decentralized and secure ledger that is used to monitor and verify transactions involving pharmaceuticals or medical data. Encryption as well as decentralization features of blockchain help to enhance the safety of patient medical records. Furthermore, blockchain has the potential to prevent falsified drugs. Overall effectiveness can be enhanced due to the decentralised transaction feature of this technology. From this study, it is clear that the features of blockchain technology like accuracy, decentralisation, immutability help to prevent the falsified drugs as well as data hacking in hospitals. Drugs can be traced from the manufacturer to the patients and each transaction is registered in each block, so the tampering of records as well as fake drugs can be prevented. Proof of Ownership and transparent drug distribution can be achieved by using this decentralised network. Furthermore, real-time monitoring of the drug by this technology helps to prevent fake drugs from entering the market. Blockchain can provide a tamper-proof as well as secure system for maintaining electronic health records. This in turn helps to minimize the threat of data breaches, enhance interoperability and make it easier for doctors as well as the healthcare to share medical data records.

5.2 CONSEQUENCES OF FAKE MEDICINE AND MEDICAL RECORD HACKING IN HEALTHCARE

Falsified drugs are those that are deliberately falsified in terms of proof of identity, structure, or origin. These drugs are becoming more prevalent in the Indian healthcare sector, having significant implications on patients as well as healthcare professionals. Around 60 participants believe that, antibiotic resistance, adverse drug reactions, treatment failure, and increased healthcare costs are the major consequences of falsified drugs. The major consequences of falsified drugs in Indian healthcare were analysed and interpreted from the survey theses were;

ANTIBIOTIC RESISTENCE

When germs evolve and become immune to the medicines employed for treating them, antibiotic resistance arises. Falsified medications may contribute to the development of antibiotic-resistant types of germs. Most of the people believe that, antibiotic resistance is the main consequences in Indian healthcare (Buowari, 2012b) .

ADVERSE DRUG REACTIONS

When a person has a not desirable or hazardous response to a medical treatment, this is known as an adverse drug reaction. Falsified drugs can contain hazardous substances or incorrect quantities of active components, leading users to experience uncomfortable medication responses**.**

TREATMENT FALIURE

Falsified medications can lack the active ingredients required for treating a medical condition efficiently, this can result in treatment failure and potentially worsen patient outcomes**.**

INCREASED HEALTHCARE COST

Falsified drugs can augment the healthcare cost by prolonging the disease, requiring extra treatments or hospitalisations and raising the necessity for higher priced medications. Furthermore, it can be very expensive for the hospitals as well as regulatory agencies to discover as well as investigate the fake drugs.(Buckley *et al.*, 2013a)From this research study, it is clear that the major consequences faced by the medical data hacking these were;

REPUTATIONAL DAMAGE OF THE HOSPITAL

Based on the survey, the main consequences faced by the data hacking in healthcare is the decreased patient trust as well as confidence in hospitals (36.2%). Patients are likely to lose

trust in a healthcare service, which had a medical data hacking incident. Patients may be reluctant to share their personal information as well as sharing sensitive data in the hospital.

FINANCIAL LOSS

Financial loss is the other consequences supported by the healthcare professionals. Clean-up cost such as investing fund for security measures to restrict the future data breaches in healthcare, recruiting forensic experts as well as providing protection service to the victims and indirect costs such as patient loss as well as reputational damage can affect the revenue of the healthcare (Seh *et al.*, 2020a).

INCREASED RISK OF THEFT AND FRAUD

Medical data include credit card, social security number as well as bank account number. With the help of these details hackers can make fake identities to purchase resaleable medicinal products or medications or they can link a person's number with fake provider number and make false insurance claims. Furthermore cyber hackers can blackmail the patients with the help of this data (Khan and Hoque, 2018).

These are the major consequences of falsified drugs as well as medical data hacking in Indian healthcare. From this research study it is clear that, in order to address these issues, the awareness as well as education should be provided among the healthcare professionals as well in patients. Regulatory authorities in India need to assign law enforcement agencies to identify the fake drugs as well as medical data hacking occurring in Indian healthcare.

5.3 HOW BLOCKCHAIN TECHNOLOGY CAN BE USEFUL TO PREVENT FALSIFIED DRUGS AND MEDICAL DATA BREACHES IN INDIAN HOSPITALS?

Blockchain is an innovative solution to prevent the falsified drugs as well as data hacking in Indian healthcare. A decentralized drugs sales ledger is one method of blockchain technology that may use to prevent the sale of fake medications in Indian healthcare. Data put into the platform cannot be modified or deleted because the record of blockchain transactions is immutable. This feature ensures the integrity of the drugs by establishing a transparent record of drugs from the manufacturers to the patients. With the help of QR code on the drugs patients as well as healthcare providers can easily access full information regarding the drugs. Therefore, the entry of fake drugs can be prevented, this mechanism is employed in the Indian healthcare to prevent the falsified drugs entering the healthcare sector. Blockchain employs

complex encryption as well as decentralising the data across multiple nodes, this mechanism aids to prevent medical data hacking in Indian healthcare. Encryption in which the data are converted into codes that can only decrypted by authorised persons with keys. This encryption algorithms helps to prevent the medical data hacking in healthcare.

5.4 CHALLENGES IN IMPLEMENTING THE BLOCKCHAIN IN INDIAN HOSPITALS.

The major challenges analysed and interpreted from the survey are follows:

LACK OF AWARENESS ABOUT THE BLOCKCHAIN TECHNOLOGY

One of the main challenges of adopting blockchain technology in Indian healthcare is the lack of awareness about the blockchain technology**.** Some of the healthcare professionals believe that blockchain technology is beneficial only for the financial sector. In Indian healthcare industries, inadequate knowledge and understanding of the technology of blockchain could lead to misconceptions or hinder its development of proficiency within this area. Correct utilization of the technology is required. In the Indian healthcare industry, efficient interaction and training about the blockchain technology is vital. The sharing of ideas between stakeholders, can increase understanding of the possible benefits associated with blockchain technology, including as secure information exchange, healthcare tracking, and preventing the distribution of counterfeit drugs.

HIGH COST OF IMPLEMENTATION

Based on the findings collected from the survey, the high cost of implementation is the second major challenge in the adoption of blockchain technology in healthcare. The major reasons are the requirement for advanced software as well as hardware required for the implementation of blockchain technology. Other reasons is the money needed for the training of healthcare professionals as well as hiring blockchain specialists will increase the cost .Furthermore, it is very expensive to combine this innovative technology with the existing systems because the old system may not have any upgraded software ,so investments are required for the upgradation of the existing technologies (Botene *et al.,* 2021) .

SCALABILITY

Scalability is another challenge in the implementation of blockchain in Indian healthcare. Seven percent of those surveyed cited low scalability as an important obstacle. A system based

on blockchain technology can get more cumbersome and inefficient when it receives additional users as well as payments.

OTHER CHALLENGES

A Small percentage of people in the survey opine that limited scalability, difficulty in interoperability and the concerns about the regulatory requirements and data security are the other challenge in the adoption of blockchain technology. Interoperability can constrain the healthcare providers to share the medical records in various blockchain based systems. Some believed that the regulations should be implemented for the safety as well as the privacy of patient records.

5.5 LIMITATIONS AND RESEARCH CONTRIBUTIONS

Most of the articles were focused on finance as well as application of blockchain pharmaceutical industry supply chain in India. Only few papers were focussed on the adoption of blockchain technology in healthcare sector as well as the application and challenges of blockchain technology in Indian healthcare.

Even though the healthcare sector comprehends the necessity of implementing blockchain technology, lack of awareness is the main barrier to expand the technology in India. One of the main aims of the study is to create awareness about the blockchain technology among healthcare professionals. From, this study it was evident that, some healthcare professionals were not aware about the blockchain technology. Moreover, with the help this research study, researcher was able to clarify as well as dispel many misunderstandings among healthcare professionals regarding the adoption of blockchain technology in Indian healthcare.

The major limitations of this research study were the small sample size. Samples were taken only from southern part of India because of the limited time period provided for the completion of the study, Although the survey questionnaire was sent to 500 healthcare professionals, only 130 participants responded to the survey. Some participants were refused to participate in the survey because they were not aware of the concepts of blockchain technology and others have lot of have misconception about the blockchain technology that it is only restricted to financial sectors. In order to access the knowledge regarding the blockchain among the healthcare professionals, larger as well as diverse populations needs to be served. Most of the questions in the questionnaire were close ended, in order to elicit more data, it could be better to include more open-ended questions in the survey questions. From the collected data as well as from

the literature review, it can be concluded that, implementing blockchain in all hospitals in India helps to prevent the falsified drugs as well as the medical data hacking.

5.6 ADDITIONAL CONSIDERATIONS

Blockchain in healthcare requires a competent workforce with experience, therefore education, as well as training should be given to healthcare professionals to comprehend the mechanism behind this technology. Furthermore, sufficient funds should be provided by the government because the application of this technology in Indian healthcare will require infrastructural expenditures such as broadband connectivity as well as cloud-based computing, particularly in rural areas. Blockchain specialists as well as programmers should be appointed to ensure that the blockchain is working efficiently and they need to evaluate the quality of the blockchain created in healthcare sectors before the implementation of blockchain technology in every sector. A combined effort from all healthcare professionals is required for the implementation of blockchain technology in all hospitals in India. Apart from that, the success of blockchain mainly relies on the implementation of blockchain in all healthcare sectors. The government should develop laws as well as regulations to encourage the adoption of blockchain in hospitals while maintaining data privacy as well as security.

5.7 RECOMMENDATIONS FOR FUTURE STUDY WORKS

From this research study, it is evident that blockchain can prevent the falsified drugs and fake data hacking in Indian healthcare in the following aspects:

- Technology can provide secure as well as decentralised storage of health data.
- Technology ensures that all data are tamper proof.
- Blockchain technology's transparency can assist in the prevention of the purchase and transportation of fake drugs in India.

The findings from both literature review as well as primary data emphasise that the blockchain is a highly effective tool for achieving operational excellence. Future studies could include a more extensive sample size that encompasses the remaining regions of India. The research study could also be widened by including a blockchain specialist to evaluate how blockchain technology can prevent data hacking and falsified drugs because blockchain specialists in the research study can provide more insight into the potential blockchain technology in the healthcare industry. Need to investigate the potential impact of the technology in the healthcare

sector, which include the potential of the technology to enhance efficiency as well as minimize the cost. Moreover, frameworks need to be developed for deploying blockchain in the healthcare sector to make sure interconnection with current technologies. The research based on the blockchain should find the methods to solve the concerns of the people regarding privacy and data security This research study could serve as a foundation for further studies to be carried out in the future. This research study shows that further study is still feasible in the area of blockchain technology. The study regarding the potential of blockchain technology in healthcare has recently been stated. To gain a more profound understanding of this novel technology, further extensive research is needed. Blockchain technology needs a strong as well as reliable information technology system in order to work efficiently.

6. REFERENCE

Adsul, K.B. and Kosbatwar, S.P. (2020) (2539) 'A Novel Approach for Traceability & Detection of Counterfeit Medicines Through Blockchain'. Available at: https://easychair.org/publications/preprint/QJNf (Accessed: 5 April 2023).

Agbo, C.C., Mahmoud, Q.H. and Eklund, J.M. (2019) (2) 'Blockchain Technology in Healthcare: A Systematic Review'. *Healthcare*, 7(2), p. 56. DOI: 10.3390/healthcare7020056.

Aminu, N. and Maikiyo, A. (2016) 'Counterfeit and Fake Medicines and Their Threat to Delivery of Quality Health Care to Our Society: A Way Forward'. *IMAN Medical Journal*, 2, pp. 21–29.

Bell, L. *et al.* (2018a) 'Applications of Blockchain Within Healthcare.' *Blockchain in Healthcare Today*. Available at: https://napier-repository.worktribe.com/output/1191195/applications-of-blockchain-within-healthcare (Accessed: 5 April 2023).

Botene, P.H.R., de Azevedo, A.T. and de Arruda Ignácio, P.S. (2021) 'Blockchain as an Enabling Technology in the COVID-19 Pandemic: A Systematic Review'. *Health and Technology*, 11(6), pp. 1369–1382. DOI: 10.1007/s12553-021-00593-z.

Buchanan, P.D. and Bryman, P.A. (2009) *The Sage Handbook of Organizational Research Methods*. SAGE Publications Ltd.

Buckley, G.J. *et al.* (2013a) *The Effects of Falsified and Substandard Drugs*. National Academies Press (US) Available at: https://www.ncbi.nlm.nih.gov/books/NBK202526/ (Accessed: 6 April 2023).

Buowari, O.V. (2012a) (2) 'Fake and Counterfeit Drug: A Review'. *Afrimedic Journal*, 3(2), pp. 1–4.

Chattu, V.K. *et al.* (2019) (2) 'The Emerging Role of Blockchain Technology Applications in Routine Disease Surveillance Systems to Strengthen Global Health Security'. *Big Data and Cognitive Computing*, 3(2), p. 25. DOI: 10.3390/bdcc3020025.

Chika, A. *et al.* (2011) 'The Menace of Fake Drugs: Consequences, Causes and Possible Solutions'. *Research Journal of Medical Sciences*, 5(5), pp. 257–261. DOI: 10.3923/rjmsci.2011.257.261.

Doreen, D. *et al.* (2022) 'Secured Cyber Security Algorithm for Healthcare System Using Blockchain Technology'. *Intelligent Automation & Soft Computing*, 35(2), pp. 1889–1906. DOI: 10.32604/iasc.2023.028850.

(Dutta et al., 2020) *Blockchain Technology in Supply Chain Operations_ Applications, Challenges and Research Opportunities | Elsevier Enhanced Reader*. DOI: 10.1016/j.tre.2020.102067.

Elangovan, D. *et al.* (2022) 'The Use of Blockchain Technology in the Health Care Sector: Systematic Review'. *JMIR Medical Informatics*, 10(1), p. e17278. DOI: 10.2196/17278.

Gallaire, H., Minker, J. and Nicolas, J.-M. (1989) 'Logic and Databases: A Deductive Approach'. In Mylopolous, J. and Brodie, M. (eds.) *Readings in Artificial Intelligence and Databases*. San Francisco (CA): Morgan Kaufmann, pp. 231–247. DOI: 10.1016/B978-0-934613-53-8.50020-0.

Goddard, W. and Melville, S. (2004) *Research Methodology: An Introduction*. Juta and Company Ltd.

Griggs, K.N. *et al.* (2018) 'Healthcare Blockchain System Using Smart Contracts for Secure Automated Remote Patient Monitoring'. *Journal of Medical Systems*, 42(7), p. 130. DOI: 10.1007/s10916-018-0982-x.

Haq, I. and Muselemu, O. (2018) 'Blockchain Technology in Pharmaceutical Industry to Prevent Counterfeit Drugs'. *International Journal of Computer Applications*, 180(25), pp. 8–12. DOI: 10.5120/ijca2018916579.

Hölbl, M. *et al.* (2018) (10) 'A Systematic Review of the Use of Blockchain in Healthcare'. *Symmetry*, 10(10), p. 470. DOI: 10.3390/sym10100470.

James Brogan (2022) *The Growing Impact of Healthcare Data Breaches*. *Healthcare Blog*. Available at: https://www.experian.com/blogs/healthcare/2022/09/the-growing-impact-of-healthcare-data-breaches/ (Accessed: 28 March 2023).

Jayaraman, R., Salah, K. and King, N. (2019) 'Improving Opportunities in Healthcare Supply Chain Processes via the Internet of Things & Blockchain Technology'. *International Journal of Healthcare Information Systems and Informatics*, 14, pp. 49–65. DOI: 10.4018/IJHISI.2019040104.

Jennath, H.S., Anoop, V.S. and Asharaf, S. (2020) 'Blockchain for Healthcare: Securing Patient Data and Enabling Trusted Artificial Intelligence'. *International Journal of Interactive Multimedia and Artificial Intelligence*, 6(3), p. 15. DOI: 10.9781/ijimai.2020.07.002.

Joda, A.E. *et al.* (2017) 'Fake Drugs: A Survey of Healthcare Providers in Lagos State, Nigeria'. *Nigerian Journal of Basic and Clinical Sciences*, 14(2), p. 137. DOI: 10.4103/njbcs.njbcs_4_17.

Kamoun, F. and Nicho, M. (2014) 'Human and Organizational Factors of Healthcare Data Breaches: The Swiss Cheese Model of Data Breach Causation And Prevention'. *International Journal of Healthcare Information Systems and Informatics*, 9(1), pp. 42–60. DOI: 10.4018/ijhisi.2014010103.

Katuwal, G.J. *et al.* (2018) (arXiv:1812.02776) Available at: http://arxiv.org/abs/1812.02776 (Accessed: 30 January 2023).

Khan, S.I. and Hoque, A.S.L. (2018) 'Digital Health Data: A Comprehensive Review of Privacy and Security Risks and Some Recommendations'.

Liu, J. *et al.* (2018) 'BPDS: A Blockchain Based Privacy-Preserving Data Sharing for Electronic Medical Records'. In *2018 IEEE Global Communications Conference*

(GLOBECOM). GLOBECOM 2018 - 2018 IEEE Global Communications Conference. Abu Dhabi, United Arab Emirates: IEEE, pp. 1–6. DOI: 10.1109/GLOCOM.2018.8647713.

McCusker, K. and Gunaydin, S. (2015) 'Research Using Qualitative, Quantitative or Mixed Methods and Choice Based on the Research'. *Perfusion*, 30(7), pp. 537–542. DOI: 10.1177/0267659114559116.

McGhin, T. *et al.* (2019) 'Blockchain in Healthcare Applications: Research Challenges and Opportunities'. *Journal of Network and Computer Applications*, 135, pp. 62–75. DOI: 10.1016/j.jnca.2019.02.027.

Meisner, M. (2017) (3) 'FINANCIAL CONSEQUENCES OF CYBER ATTACKS LEADING TO DATA BREACHES IN HEALTHCARE SECTOR'. *Copernican Journal of Finance & Accounting*, 6(3), pp. 63–73. DOI: 10.12775/CJFA.2017.017.

Priya Isravel,Martin Sagayam (2015) *Blockchain for Healthcare Systems: Architecture, Security Challenges, Trends and Future Directions | Elsevier Enhanced Reader*. DOI: 10.1016/j.jnca.2023.103633.

Ratta, P. *et al.* (2021) 'Application of Blockchain and Internet of Things in Healthcare and Medical Sector: Applications, Challenges, and Future Perspectives' Khan, R. (ed.). *Journal of Food Quality*, 2021, pp. 1–20. DOI: 10.1155/2021/7608296.

Saha, A. *et al.* (2019) 'Review on "Blockchain Technology Based Medical Healthcare System with Privacy Issues"'. *Security and Privacy*, 2. DOI: 10.1002/spy2.83.

Sapsford, R. and Jupp, V. (1996) *Data Collection and Analysis*. SAGE.

Saunders, M., Lewis, P. and Thornhill, A. (2007) *Research Methods for Business Students*. Pearson Education.

Seh, A.H. *et al.* (2020a) (2) 'Healthcare Data Breaches: Insights and Implications'. *Healthcare*, 8(2), p. 133. DOI: 10.3390/healthcare8020133.

Seh, A.H. *et al.* (2020b) 'Healthcare Data Breaches: Insights and Implications'. *Healthcare*, 8(2), p. 133. DOI: 10.3390/healthcare8020133.

Seiter, A. (2009) 'Health and Economic Consequences of Counterfeit Drugs'. *Clinical Pharmacology and Therapeutics*, 85(6), pp. 576–578. DOI: 10.1038/clpt.2009.47.

Shahnaz, A., Qamar, U. and Khalid, A. (2019) 'Using Blockchain for Electronic Health Records'. *IEEE Access*, 7, pp. 147782–147795. DOI: 10.1109/ACCESS.2019.2946373.

Siyal, A.A. *et al.* (2019a) (1) 'Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives'. *Cryptography*, 3(1), p. 3. DOI: 10.3390/cryptography3010003.

Siyal, A.A. *et al.* (2019b) (1) 'Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives'. *Cryptography*, 3(1), p. 3. DOI: 10.3390/cryptography3010003.

Snyder, H. (2019) ‘Literature Review as a Research Methodology: An Overview and Guidelines’. *Journal of Business Research*, 104, pp. 333–339. DOI: 10.1016/j.jbusres.2019.07.039.

Sultan, K., Ruhi, U. and Lakhani, R. (2018) ‘Conceptualizing Blockchains: Characteristics & Applications’.

SÜRÜCÜ LMASLAKÇI A (2000) *VALIDITY AND RELIABILITY IN QUANT... Preview & Related Info | Mendeley*. Available at: https://www.mendeley.com/catalogue/2834774e-b754-361e-aa75-305346ee623d/ (Accessed: 29 April 2023).

Teherani, A. *et al.* (2015) ‘Choosing a Qualitative Research Approach’. *Journal of Graduate Medical Education*, 7(4), pp. 669–670. DOI: 10.4300/JGME-D-15-00414.1.

Thomas, D. (2014) ‘Thomas 2003 General Inductive Analysis - Original Web Version’.

Uddin, M. *et al.* (2021) ‘Blockchain for Drug Traceability: Architectures and Open Challenges’. *Health Informatics Journal*, 27(2), p. 14604582211011228. DOI: 10.1177/14604582211011228.

Wikina, S.B. (2014) ‘What Caused the Breach? An Examination of Use of Information Technology and Health Data Breaches’. *Perspectives in Health Information Management*, 11(Fall), p. 1h.

Xia, Q. *et al.* (2017) ‘MeDShare: Trust-Less Medical Data Sharing Among Cloud Service Providers via Blockchain’. *IEEE Access*, 5, pp. 14757–14767. DOI: 10.1109/ACCESS.2017.2730843.

Yang, H. and Yang, B. (2017) ‘A Blockchain-Based Approach to the Secure Sharing of Healthcare Data’. Available at: https://www.semanticscholar.org/paper/A-Blockchain-based-Approach-to-the-Secure-Sharing-Yang-Yang/af404093a0fe066a43e5021b7d0f2a1c7b9105e6 (Accessed: 3 May 2023).

Yue, X. *et al.* (2016) ‘Healthcare Data Gateways: Found Healthcare Intelligence on Blockchain with Novel Privacy Risk Control’. *Journal of Medical Systems*, 40(10), p. 218. DOI: 10.1007/s10916-016-0574-6.

Zabala, G.A. *et al.* (2022) ‘Substandard and Falsified Antibiotics: Neglected Drivers of Antimicrobial Resistance?’ *BMJ Global Health*, 7(8), p. e008587. DOI: 10.1136/bmjgh-2022-008587.

Zakari, N. *et al.* (2022) ‘Blockchain Technology in the Pharmaceutical Industry: A Systematic Review’. *PeerJ Computer Science*, 8, p. e840. DOI: 10.7717/peerj-cs.840.

7 APPENDICES

Questionnaire for online survey

EVALUATE HOW BLOCKCHAIN TECHNOLOGY CAN PREVENT FALSIFIED DRUGS AND MEDICAL DATA BREACHES IN INDIAN HOSPITALS

Hi,
My name is Jino Sarah Anil. I am a master's student conducting a survey as an attempt to evaluate how blockchain prevent the fake drugs as well as data hacking in hospitals. I would like to invite you to take part in a research study. Please take time to read the information attached along with this form carefully. The survey comprises multiple choice and short answers. By filling this survey, you are voluntarily agreeing to take part in the research study If you have any queries in relation to this survey, do not hesitate to contact me in the following email id jinoanil97@gmail.com

1. How long you have been working in the healthcare sector?

☐ Less than 3 years

☐ More than 5 years

☐ More than 10 years

2. Are you familiar with blockchain technology and its benefits?

☐ Yes

☐ No

3. Is there any falsified drugs or medical data breaches occurred in Indian healthcare or in your hospital?

☐ Yes

☐ No

4. What are the major consequences of falsified drugs in your hospital?

a) Antibiotic resistance

b) Treatment failure

c) Adverse drug reactions

d) Increased healthcare costs

e) All of the above

f) None

5. What are the main consequences faced by data hacking in your hospital?

a) Decreased patient trust and confidence in your hospital (reputational damage of the hospital)
b) Decreased healthcare outcomes for patients
c) Financial losses
d) Increased risk of identity theft and fraud
e) None

6. Do you think the entry of falsified drugs and data hacking can be prevented by blockchain?

☐ Yes

☐ NO

☐ Maybe

7. In your opinion, how can blockchain be helpful in preventing fake medicines in hospitals?

a) By providing a decentralized ledger of drug sales which could be used to trace and ensure the integrity of pharmaceuticals.
b) By keeping a digital record of all medications administered in hospitals
c) By enabling physicians to remotely monitor patients' health through wearable gadgets
d) Other

(Descriptive answer is expected)

8. What do you think is the key advantage of using blockchain for storing patient medical records in hospitals?

a) It provides strong security as well as privacy protection for patient records
b) It makes it easy to access patient records from anywhere in the world
c) It eliminates the need for the hospital to keep paper records
d) It guarantees that patient records are anonymous
e) All of the above

9.In your viewpoint, how does blockchain can improve the security and privacy of patient medical records in hospitals?

a) By Using complex encryption algorithms and decentralising the data across multiple nodes
b) It guarantees that all patient records are completely anonymous
c) By establishing a tamper-proof electronic record of all data transactions

d) Other options

(Descriptive answer is expected)

9. What do you see as the challenges in the adoption of blockchain technology in healthcare?

a) ☐ Limited scalability
b) ☐ Difficulty in interoperability
c) ☐ Limited awareness of the blockchain technology
d) ☐ High cost
e) ☐ Concerns about regulatory requirements and data security
f) ☐ All of the above
g) ☐ Other opinions

(Descriptive answer is expected)

10. Do you believe that blockchain use will accelerate in the future years and bring positive improvements to healthcare?

☐ Yes
☐ No
☐ Maybe

11. Do you favour the idea of implementing blockchain in your hospital?

☐ Yes
☐ NO
☐ Maybe

12. What is your opinion on the future opportunities of implementing blockchain technology in healthcare?

(Descriptive answer is expected)