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ORIGINAL RESEARCH

Impact of Using the Internet of Medical Things on e-Healthcare Performance: Blockchain Assist in Improving Smart Contract

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Background: This paper explores the use of blockchain technology and smart contracts in the Internet of Medical Things (IoMT). It aims to identify the challenges and benefits of implementing smart contracts based on blockchain technology in the IoMT. It provides solutions and evaluates the IoMT uses in e-healthcare performance.

Methods: A quantitative approach used an online survey from public and private hospital administrative departments in Dubai, United Arab Emirates (UAE). ANOVA, *t*-test, correlation, and regression analysis were performed to assess the e-healthcare performance with and without IoMT (smart contract based on blockchain).

Patients and Methods: A mixed method was used in this research, a quantitative approach for data analysis utilizing online surveys from public and private hospitals' administrative departments in Dubai, UAE. A correlation, regression through ANOVA, and independent two-sample *t*-test were performed to assess the e-healthcare performance with and without IoMT (smart contract based on blockchain).

Results: Blockchain application in smart contracts has proven to be significant in the healthcare sector. Results highlight the importance of integrating smart contracts and blockchain technology in the IoMT infrastructure to improve efficiency, transparency, and security. The study provides empirical evidence to support the implementation of smart contracts in the e-healthcare sector and suggests improved e-healthcare performance through this transition.

Conclusion: The emergence of e-healthcare systems with upgraded smart contracts and blockchain technology brings continuous health monitoring, time-effective operations, and cost-effectiveness to the healthcare sector.

Keywords: internet of medical things, IoMT, e-healthcare, smart contracts, blockchain

Introduction

The delivery and management of healthcare services are expected to change as a result of the Internet of Medical Things (IoMT), which has emerged as a disruptive force in the healthcare industry. IoMT refers to a system of interconnected sensors and medical equipment that can gather and send real-time patient data to healthcare providers. This technology can potentially enhance patient outcomes and save healthcare costs by enabling remote monitoring, individualised care, and preventive interventions.

It is crucial to comprehend the impact of IoMT on e-Healthcare performance, covering both the possible advantages and difficulties. Also, there is a need for secure and effective ways to handle and store data, given the growing amount of patient data produced by IoMT. With the usage of smart contracts, blockchain technology has emerged as a potential answer to this problem by enabling safe and open data management.

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Hence, this research aims to investigate the effects of IoMT use on the performance of e-healthcare as well as the possible contribution of blockchain technology to IoMT applications in healthcare. The article will specifically look at the advantages and drawbacks of adopting IoMT in healthcare, including how it affects patient outcomes and operational effectiveness. The research will also consider how blockchain technology could be incorporated into smart contracts to provide secure and open data management in IoMT applications.[1]

The primary focus of the research is blockchain application in the working of the Internet of Things in the healthcare sector.[2] Whereas smart contracts are also very vigilant because it decides when the contract will be initiated and should be brought to closure or end.[3] The life cycle should also be appropriately managed so that we do not have to suffer later with incomplete contracts and be unable to change or alter them.[4]

Additionally, the impact of using the Internet of Medical Things (IoMT) on e-Healthcare performance must be researched.[5] With the increasing use of connected devices and sensors in healthcare, it is important to understand the benefits and limitations of IoMT in improving the overall performance of e-Healthcare.[6]

One potential area of research is the impact of IoMT on patient outcomes, such as reduced hospital readmissions and improved medication adherence. Additionally, research could explore how IoMT can improve operational efficiency in healthcare delivery, such as reducing wait times and improving resource utilization.[7]

Another essential aspect to consider in this research is the potential role of blockchain technology in assisting with smart contracts. As IoMT generates vast amounts of data, it is important to have secure and efficient methods of handling and storing it. Blockchain technology has the potential to provide secure and transparent data management through the use of smart contracts. Additionally, this research includes problem identification, research questions to investigate, a detailed review of the literature in section 3, a demonstration of the methodology, research techniques, and overall analysis results in section 4, a critical discussion of the results in section 5, and finally a conclusion with implications and future recommendations.

Problem Definition

The research has been undertaken to identify how smart contracts operate on the blockchain and how the blockchain can be incorporated with applications based on the Internet of Medical Things in the e-healthcare sector, as presented in Figure 1. Moreover, it aims to address the challenges and benefits embedded with the concept and how the issues can be addressed before it is implemented in the real world. The need for empirical evidence is highlighted in this research that may incorporate the healthcare institutions and their responsiveness to using smart contracts with and without blockchain technology.[8,9]

Though the benefit of the Internet of Things has been defined in the above section, several questions must be addressed before smart contracts, and the IoT are implemented. The major questions that need to be addressed are:

- Why use smart contracts based on blockchains in IoMT applications?
- What is the novelty in the transition of IoMT infrastructure into such systems?
- How will the application keep up with data request processing without jeopardising security?
- How will the balance be brought between the centralization and decentralization of IoMT aspects concerning the demand?

In order to answer the above queries, a unique architecture is proposed to execute and implement smart contracts based on the IoMT in the e-healthcare system to show the application usage. The end devices of IoMT will be used in the places which will sense the data required concerning the demand of the application. The nodes of the system will be pre-programmed based on how they should process or send the data. Secondly, to incorporate the empirical evidence into this study, a hypothesized model has been developed to signify that the priority of sensitive patient data may be compromised due to the rising use of IoMT. The usage of insecure networks and the gathering and storing of data on cloud servers can both pose security risks. The use of wearable technology and the monitoring of patient behaviors might also give rise to privacy concerns.

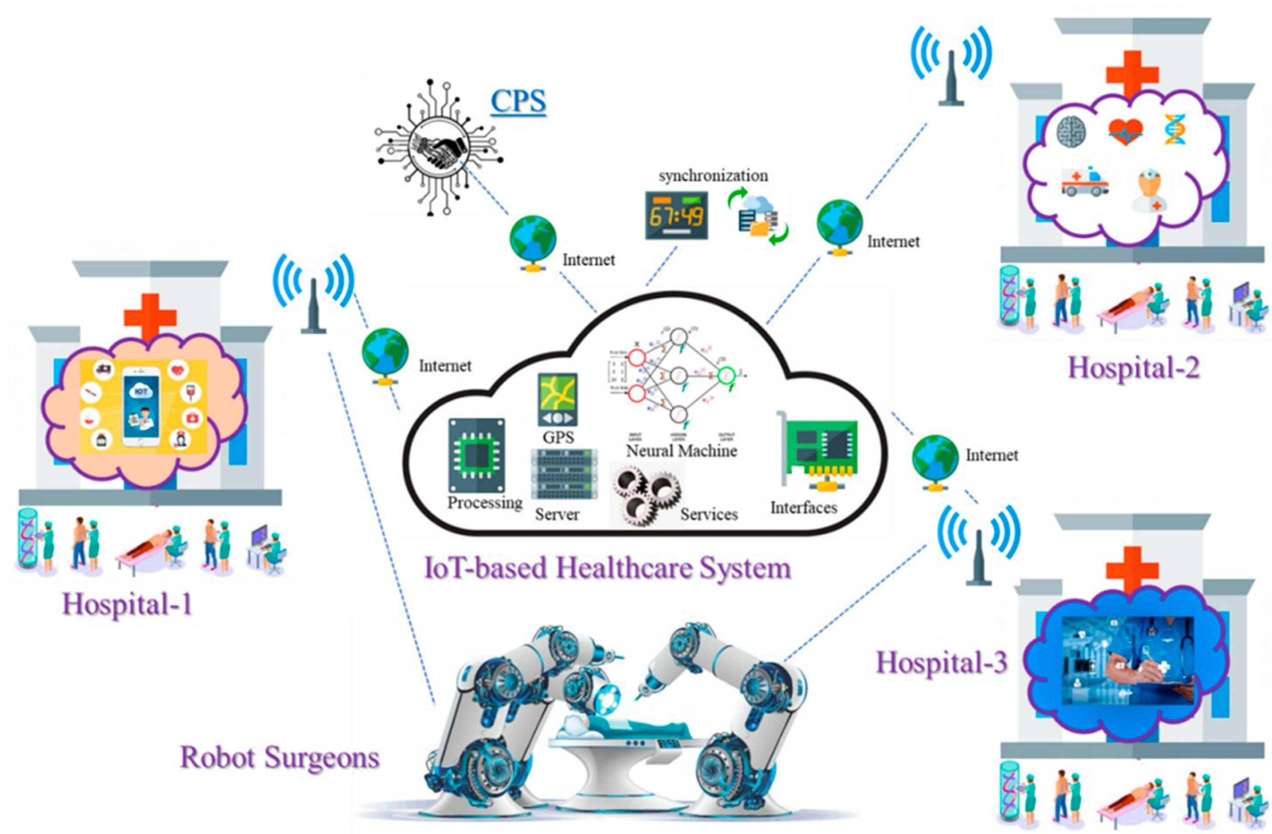

Figure 1 IoMT in e-healthcare services.

Literature Review

Blockchain was first developed for a peer-to-peer cash system in the early 1990s by a group of researchers; blockchain has since developed and been used in a wide range of situations. Because any alteration to that block will result in a rewriting of the entire transaction history, it assures that the data entered cannot be altered or erased.[10] Due to blockchain's open-source nature, numerous innovative blockchain networks have been discovered to offer distinctive characteristics and functionality in the past ten years. They include supply networks, private transactions, smart contracts, and decentralized applications. Blockchain can therefore be used to record, track, and confirm transactions without a centralized authority.[11] Blockchain combines a chain of time-stamped blocks with a cryptographic hash to identify each. The blocks can be arranged in sequence according to the date, and a hash is used to identify each block. All additional blocks contain the previous blocks' cryptographic hashes, which help sustain the prior chain.[12] The blockchain parents are known as the "genesis" blocks. Any node with access to the prior data connection structure can comprehend the data state and have access at any time and location.[13]

In addition, the blockchain nodes assign a special set of public and private keys to each blockchain node once they join the network. Asymmetric cryptography is used; it helps to make the system more authentic and brings non-repudiation and integrity to the network system.[14] When the transaction occurs, the user's private key signs it, and then the neighbor broadcasts it. The transaction's passage by the other nodes can be validated and cross-checked through the public key before it is forwarded to the network system. However, it is discarded if the transaction is invalid.[15] A time limit is set for each transaction, and after that, all the transactions are consolidated, packed, and time-stamped by the node, which acts as the system's miner.[16]

Every time a different block is mined in the system, the system nodes cross-check to determine whether the block transaction is genuine. It is broadcasted if the block has valid transitions; if it does not, it is discarded. The process continues for the specified predetermined period.[17] The execution of the nodes is done in an environment with no trust factor, but the trust is built and achieved with time, many transactions, and the block's emergence. Before they are communicated, all transactions are verified, and the blocks undergo a mining process by the nodes with a certain level of trust. Thus, trust in the blockchain becomes a valuable asset in the system of the network.[18,19]

Furthermore, blockchain nodes must be agreed on a uniform set of dealings so that the block mining and the blockchain can be updated for a certain period. The ideal scenario in the blockchain is to agree upon the blocks mined by the highest number of nodes, which is the solution.[20] Nevertheless, the major threat is when a single user inserts multiple numbers of nodes on a biased block mining decision, termed a Sybil attack. When using a miner, the block is mined, then the transaction gets locked, which is impossible to reverse back.[21] The system through which the security of the blockchain is maintained as they use a symmetric combination for the transaction validation; later and cannot be denied the blockchain's role in the transaction.[22] The body of blocks contains a set of transactions and the counter of the transactions; transaction size determines how each block can hold how many transactions.[23]

According to Gartner's Hypes cycle, blockchain has reached its peak success and use. The implication and development of blockchain are at a higher possible level.[24] Several domains are working on the applicability of the blockchain as it has several benefits. However, several architectures state that the centralized system is more effective and is still used in several domains.[25,26] In some places and areas, blockchain contracts might be utilized in a decentralized form. Trust keeping in the system is always significant, and blockchain suffices despite its threats. The list below mentions some of the application areas:

- In supply chain management, goods tracking, suppliers and reputations identification, intelligent transport systems, vehicles based on the smart system, and road traffic management.
- The integrated management system includes the e-healthcare system, smart maintenance, and diagnostic systems.
- In smart energy farming, smart agriculture, smart clothing, smart homes, and smart environment.
- In public safety and defense, law enforcement agencies, E-governance, and E-democracy.
- In the real estate market, record management, asset management, copyright protection, insurance claims, and product certification.
- In financial services trading, industry, logistics, and cyber security.

Additionally, the infrastructure of IoMT speeds up the processes of the healthcare system on the Internet, and it is termed an e-Healthcare system.[27]

IoT in health:

- IoT facilitates remote patient health monitoring.
- With a doctor's guidance, patients can record their heart rates at home, store the information in a central database for real-time analysis, and receive results the same day.

Remote Patient Care:

- Philips enables physicians to administer drugs to patients remotely and even measure their biometrics using sensors and other devices.

Patient Wait Time Prediction:

- It is a software-driven IoT system that effectively tracks availability to reduce waits for patients needing urgent care.

Chronic Disease Remediation:

- Combining wearable technology, next-generation computing, and mobile access will enhance clinical treatment and save costs for treating chronic conditions.

Smart Pharmacy and Logistics:

- The pharmacy ecosystem ensures that there are no errors in the delivery of medications, that people are protected, and that the quality of care is increased.[28]

The proposed model has incorporated smart contract applications for IoMT in the e-healthcare system, as shown in Figure 2.

A blockchain feature known as a "smart contract" enables the execution of reliable transactions between distrustful parties without the involvement of a third party.[29] It is built on computer code that follows a logical sequence and speeds up interactions between customers and service providers. The goal is to lower transaction costs while delivering improved security superior to conventional contract law. Also, it is a self-executing contract that does not require human intervention once the specified goal is achieved.[11] In the domain of IoMT, smart contracts can be used, and node numbers can be increased to millions with time to increase the number of codes. The system becomes complicated, and accordingly, monitoring the process becomes complicated. Blockchain will help in the process; it removes the need for intermediaries.[30] The intermediaries and brokers are present for decision-making and validation use but consume many resources like time and computation. Blockchain eliminates the intermediaries through nodes' participatory preparation and their collective working on behalf of the intermediaries. The primary motivation behind integrating blockchain in the IoMT of the e-healthcare system is that it will help save time, energy, and computations and increase the sensor nodes' lives. According to recent data from the McKinsey Global Institute (MGI), published in 2022 at agnitio.com, the healthcare industry lags behind other industries in using digital technology. According to the study, if the healthcare industry can catch up technologically with other sectors, there might be significant gains in innovation, productivity, and profit.[28] The primary use of blockchain lies in the management of assets where the smart contracts will be embedded with the assets, and it will define what is owned by whom at a point in time.[31] The working of the transaction occurs on a set of various data inputs; they can define as per the requirement. When they are brought into execution with IoMT, the things of the network will work as independent automated units, providing efficient results.

Smart contracts can also be attached to things and will own their unique addresses in the blockchain network. Furthermore, when the set environment variables receive any value which matches the smart contract input criteria, then

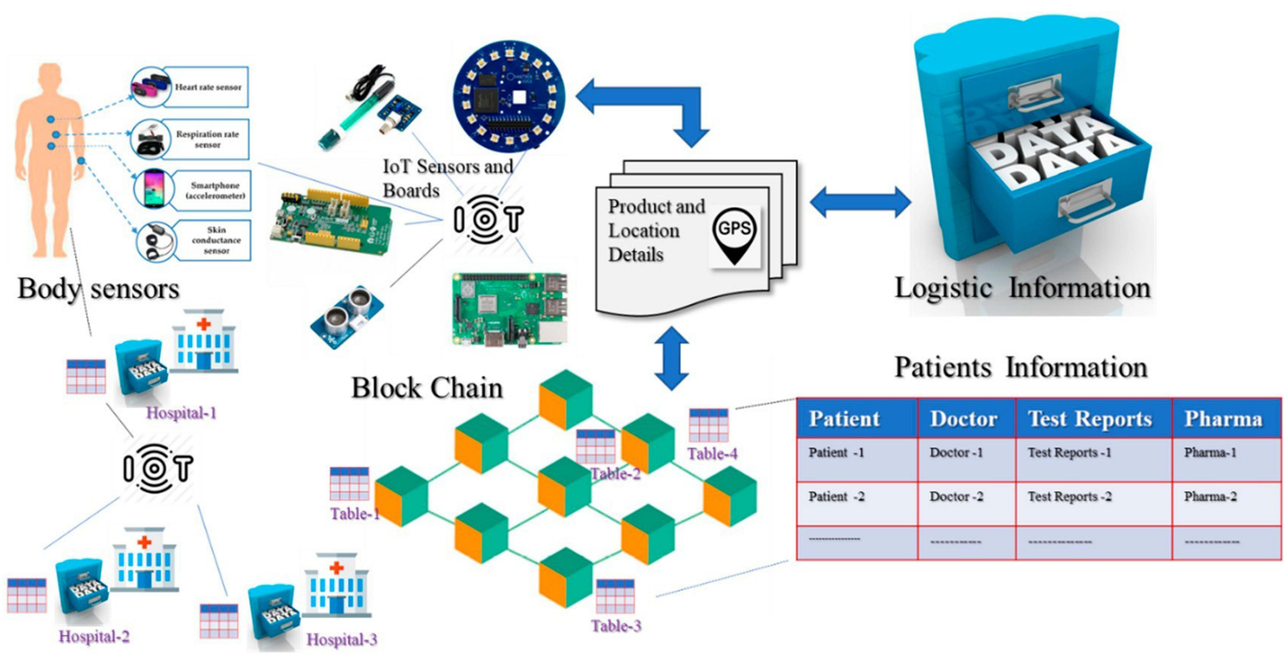

Figure 2 The architecture of Blockchain of IoMT in e-healthcare services.

it will be executed by the code.[32] Smart contracts can also be handled through the direct address of the transaction. As the blocks in the chain are connected, the exact directions execute on the other nodes. All the sets of transactions are independent; once executed cannot be reverted, making the chain tamper-proof and trustworthy.[33] A counter transaction needs to occur if one wants to reverse the transaction. Smart contracts executed over the blockchain perform well when the management of data and transactions is vast in number. The scenario is particularly good for IoMT as their amount of data is vast but has limited processing, as shown in Figure 3.[24]

Due to blockchain's considerable success and implications in various fields and disciplines, researchers have proposed using blockchain in the healthcare system to provide security for patients' confidential data over the cloud. Several researchers have provided various frameworks for integrating security mechanisms for transferring data over the cloud.[15,34] Once the data is transferred to the cloud, the other stage is incorporating blockchain in the healthcare system so that the data can be transferred to the cloud to avoid issues in key data management.[35] Decentralized blockchain technology has replaced the critical management issues of the centralized system in the healthcare system. The authors have defined the importance of blockchain and the use of blockchain in decentralized healthcare systems; therefore, each log and every file has been maintained efficiently in the system.[14] The system has enabled the elimination of brokerage and intermediate costs.

Moreover, the researchers have proposed another architecture for exchanging medical records by introducing advanced blockchain technology. It has been proposed to meet the growing demands in the healthcare system. It has also been stated that it will reduce the intermediate cost of exchanging patients' medical records.[36] Three hypotheses

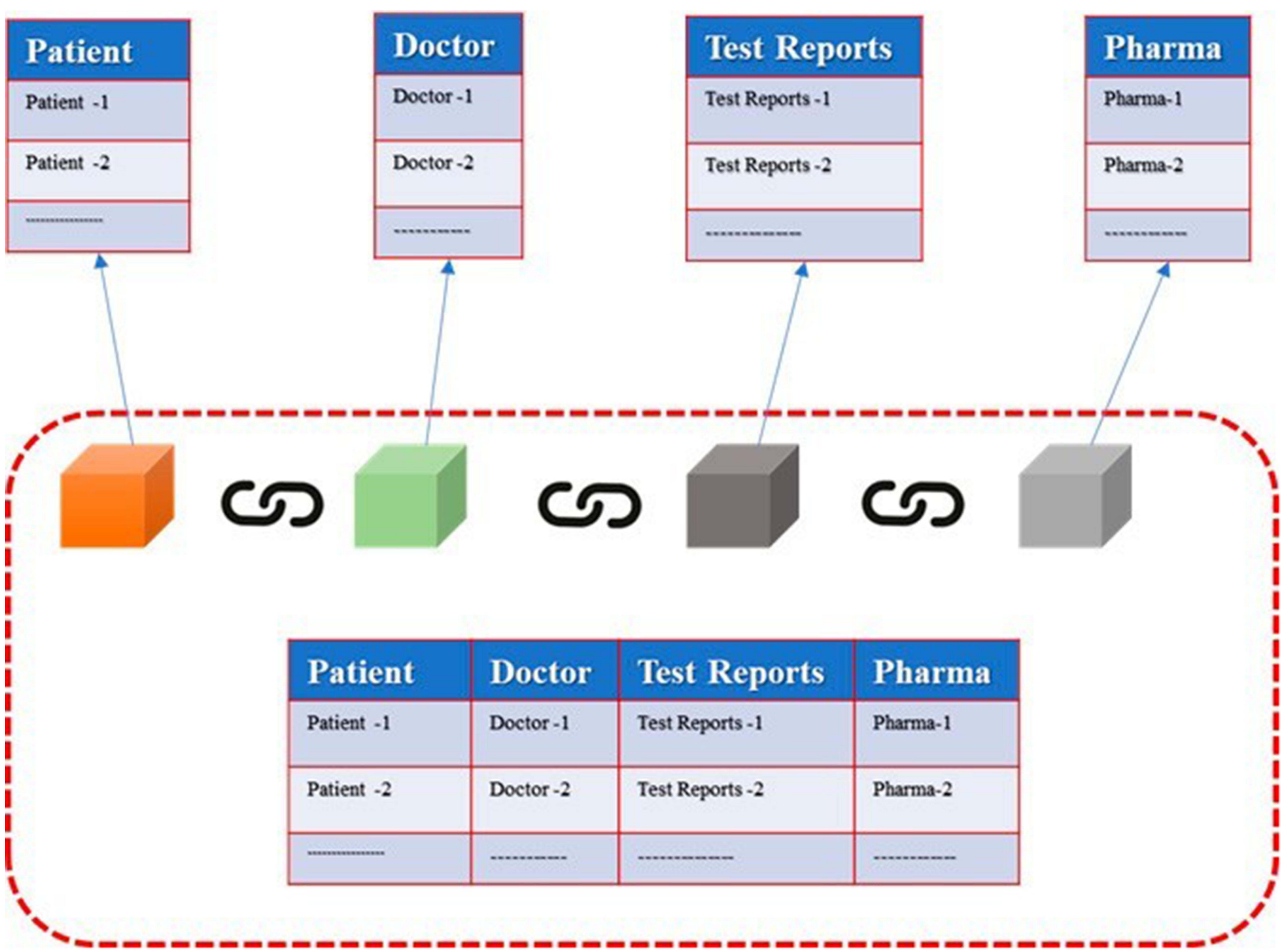

Figure 3 A decentralized blockchain-based smart contracts system for IoMT of e-healthcare.

were developed to evaluate the outcomes of this research based on the critical discussion of the literature mentioned above:

- **H₁**: Using IoMT has a positive impact on e-healthcare performance.
- **H₂**: Blockchain-based smart contracts have a positive impact on e-healthcare performance.
- **H₃**: There are significant positive differences in the impact of IoMT on e-healthcare performance attributed to using smart contracts with and without blockchain enabled.

The research proposed model is shown in Figure 4.

Methodology

Research Design and Technique

Logic of research techniques: This study aims to describe, compare, and analyze the importance of smart contract testing methodologies and analytical tools accessible with blockchain technology in IoMT with the help of primary and secondary data. A mixed-method research approach was applied for the investigation of the research proposition. A qualitative approach addresses the importance of using blockchain-based smart contracts in IoMT applications. In contrast, a quantitative approach was used to assess the research hypotheses, examine the impact of using IoMT in e-Healthcare performance, and evaluate if there is a difference between with and without blockchain-based smart contracts.

Targeted Population and Data Collection: Given the purpose of the study, the healthcare industry was the target demographic. Information was gathered from 16 healthcare facilities in order to compile responses to questions about the use of smart contracts in the Internet of Things. 6 public hospitals and ten private hospitals in Dubai, United Arab Emirates, provided information, and the administrative departments of each institution were contacted to complete the questionnaire. Three hundred emails containing questionnaires were distributed, and a valid size of 134 was used for data analysis.

Methods and Procedures of Data Analysis: Statistical tests have been conducted by SPSS, such as ANOVA analysis, regression analysis, correlation analysis, and Independent two-sample *t*-test to evaluate the validation of the research model proposing two groups.

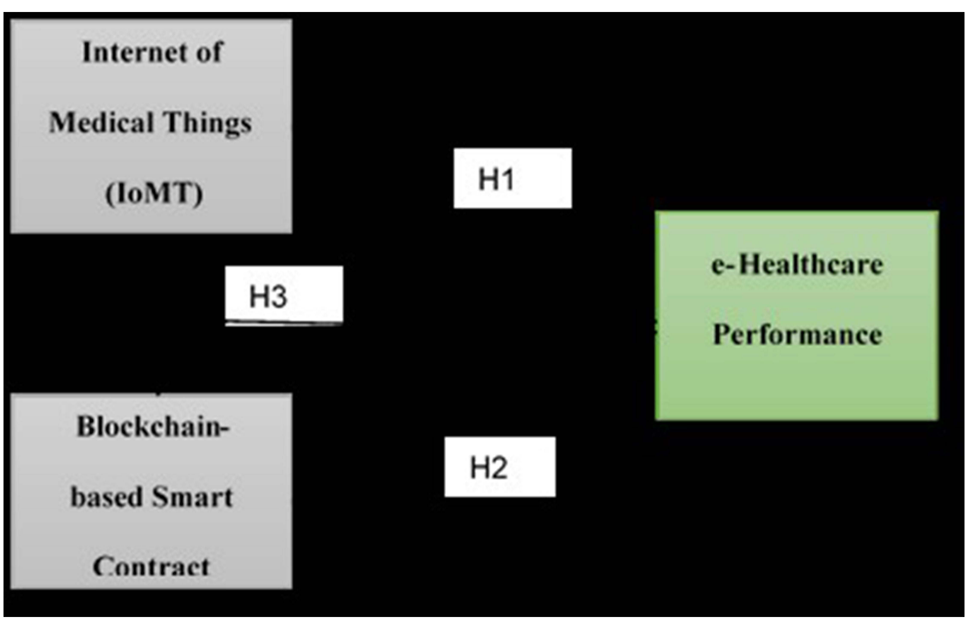

Figure 4 Hypothesized research model.

Questionnaire Design:

The questionnaire was developed by authors based on a five-point Likert scale identifying the 1= "strongly disagree" to 5= "strongly agree". Two section items were used to get responses: one section includes the demographic details of the respondents, such as "gender", "age", and "experience". The other section contains ten items to measure the hypothesis, intention to use IoMT impact on e-Healthcare performance, and eight items used to measure the use of smart contracts based on blockchain in the healthcare sector.

Results

Correlation Coefficients

Analyzing the correlation among variables helps to identify the relationship and significance level of the variables. This analysis finds a strong positive correlation between IoMT and smart contracts based on blockchain r=0.860**, P<0.05. IoMT and e-HC performance are predicted to be highly correlated with r=0.703**, P<0.05. Lastly, the correlation between smart contracts based on blockchain represents a strong correlation with significance level r=0.744**, P<0.05, respectively. Table 1 illustrates the correlation results.

Regression Analysis

Table 2 demonstrates regression analysis of the proposed model that predicts a significant positive relationship between IoMT and e-Healthcare with beta value $^{\beta}$=.90, R=70 R^2=.490, t=2.02, p<0.05 depicted a positive prediction of IoMT dependency on e-healthcare. Similarly, the beta coefficients for smart-contract-based blockchain significantly relate to e-healthcare performance $^{\beta}$=.64, R=0.74, R^2=.547, t=4.31, p<0.05 represents a significant positive relationship with a strong correlation. IoMT and Smart contracts based on blockchain are significantly associated with e-healthcare performance ($^{\beta}$=.78, R=0.62, R^2=.384, t=9.34, p<0.05) that predicted a significant impact of the model variables. A summary of the results is given in Table 2.

Table 1 Correlation Analysis

Construct	Internet of Medical Things (IoMT)	Smart Contract Based on Blockchain	e-Healthcare Performance
Internet of Medical Things (IoMT)	1		
Smart contract based on Blockchain	0.860	1	
e-Healthcare Performance	0.703	0.744	1

Note: Significant Level: *P*<0.001 *P*<0.05.

Table 2 Regression Analysis Through ANOVA

Hypothesis	Standardized Coefficients						
	Beta	R	R^2	f	t-value	Sig*	Alternative Hypothesis Status
H1: IoMT → e-healthcare	0.90	0.70	0.490	586.13	2.02	0.001	Accepted
H2: Smart Contract based on blockchain→e-healthcare Performance	0.64	0.74	0.547	341.58	4.31	0.001	Accepted
H3: Smart Contract based and e-healthcare Impact on Blockchain	0.78	0.62	0.384		9.34	0.000	Accepted

Note: *Significant level at: *P*<0.001, *P*<0.05.

Abbreviations: IoMT, Independent Variable; Smart Contract based on Blockchain, Independent Variable; e-Healthcare Performance, Dependent Variable.

Table 2 demonstrates a brief regression analysis indicating the R-value shows the strong association of relationship variables based on statistical analysis. The figures show how variations in smart contracts and IoMT usage might affect the effectiveness of e-healthcare. As a result, we can conclude that H1 is accepted. Our statistical research shows that IoMT use significantly affects the effectiveness of e-Healthcare. In our statistical analysis, H2 is supported with a significance level that elaborates prior research evidences a positive impact of smart contracts based on blockchain on e-healthcare performance. However, the results also revealed that the performance of e-healthcare can improve in direct proportion to how well smart contracts are used. Thus, it is possible to conclude that our research hypothesis, H3, is accepted because there are differences between how well e-healthcare performs when smart care contracts are used with and without blockchain.

Independent Two-Sample *t*-test

Two-sample group result analysis revealed a small mean difference between the groups, "One who are using smart contracts based on blockchain" and others "Who are using smart contracts without blockchain". The statistical findings show differences between the two groups (Smart contract with and without blockchain enabled) using IoMT with e-healthcare performance. Thus, based on significant value, we accept the alternative Ho3 since the mean is unequal for both groups. The mean value for Group 1 (G1) =3.49, t-stat=−1.39, $P<0.05$. The mean value from Group 2 (G2) =4.20, STD=0.94, t-stat=−1.37, $P<0.05$. Based on the results of the significance of Ho2, we accept the Alternative Hypothesis in the proposed model. Table 3 demonstrates the statistical results.

Blockchain-Based on Smart Contracts Working for IoMT in E-Healthcare

A decentralized blockchain system centered on smart contracts for IoMT generates and integrates all the patient information with their records, including the doctor's details, their prescription information, medication details, and lab report information. The data flows from one block to the next, creating a chain, with the data holder serving as the first block. A hash is always present at the beginning of the chain, and it moves as a message each time a move is made. The IoMT model for e-Algorithm Healthcare 1 has been established, as shown in Table 4.

A chain of all the blocks can be created using the preceding block's hash. To make things more straightforward, imagine that every piece of information is kept in every block when a patient receives therapy for any disease. Anyone attempting to alter the data will need to change the hash first. It will cause the hash to transfer incorrectly to the following block. As a result, everyone will become aware of the activities. Anyone who attempts to do so effectively would also need to alter the hash values of the following blocks, which is not possible.

For the execution, the proposed system must be implemented through MATLAB Simulink, with 8 GB RAM, core i5-7400 CPU, 3.00 GHz processor, and operating Windows 10. The framework based on the smart contracts for the trusted blocks has been given in the paper. The nodes along their block were given in the simulation, each assuring trust between the blocks. For testing the proposed model, the system has been added to the healthcare system mentioned in Table 5.

The simulation has been done by developing three different nodes and link sets. Node sets are comprised of links, and these links make the chain. For the experiment, a data set with the size of traffic information bits 1024 has been transmitted with data of e-healthcare. The block is linked with 20 energy joules assigned as the trust value for the security of the data. Six joules of energy were associated with each node for consideration of the non-malicious nodes, and miners were sent with 4 joules of energy.

Table 3 Independent Two-Sample *t*-test

Groups	N	Mean	Std. Deviation	df	t-Stats	sig
Using Smart Contracts based on Blockchain	84	3.49	0.79	132	−1.39	0.003
Using Smart Contracts without Blockchain	50	4.20	0.94	98.870	−1.37	0.006

Note: 95% Confidence Interval - Sig $P<0.05$.

Table 4 Blockchain-Based Smart Contracts for IoMT in e-Healthcare

Input	Delay, Capacity, Energy, data Traffic
Output	Data transmitted with the blockchain in e-healthcare

Begin {
Step 1: Declaration of variables
Step 2: Set the threshold values of legitimacy for miner with energy (E_{THM})
Step 3: Set the threshold values of legitimacy for block with energy (E_{THB})
Step 4: if (E_{THM} ≥ Threshold)
Step 5: if (E_{THB} ≥ Threshold)
The hash of the block added to the data, and authentication was conducted with the next block in the chain.
Step 6: else
Hash of previous block compromised and removed //Go to step 5
Step 7: end if
Step 7: end if
Step 8: end if
Step 9: Data transmitted with the blockchain-based smart contract for IoMT in e-healthcare
} end

Table 5 List of Network Attributes

Sr. No.	List of Network Attributes	Attribute Value
1	Total nodes (blocks)	100, 200 and 300
2	Total links (chains)formulated	4600, 18,500 and 41,500
3	Network size	1000 m x 1000 m
4	Information traffic	1024 bite
5	Simulation time	120 s
6	Energy associated with nodes (blocks)	10 J

For performing the malicious activities in the network, all the node sets have been added with particular sets of malicious nodes like 5, 35, and 50. The miner (malicious), like 10, 50, and 100, were also added due to the entire attack of grey. In the system, as the doctor gives the patient a prescription, the information is sent to the miner set in the network.

The data generated from each node is further cross confirmed with the hash and miner data. If the block confirmation fails, the previous block's legitimacy also fails. This research compares the proposed system and algorithm with the previous one. Several parameters have been undertaken for comparison. Table 6 shows the configuration of nodes and mines with malicious nodes and miners.

Table 6 Configuration of Nodes and Mine

Network with Different Nodes	Malicious Blocks	Miner Blocks/Nodes
100	5	10
200	25	50
500	50	100

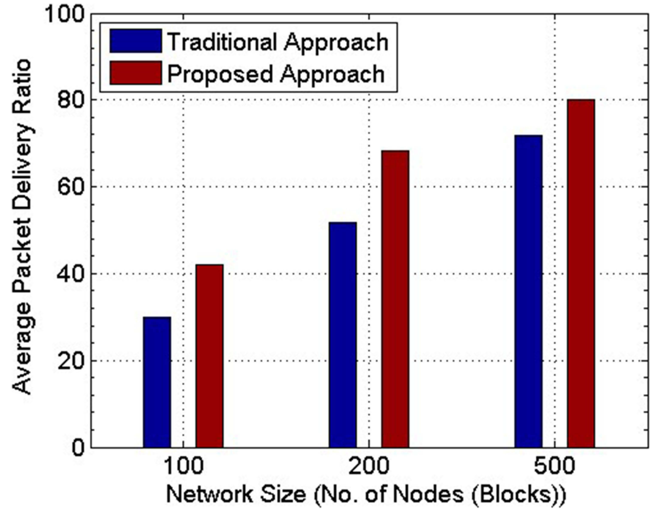

Figure 5 Packet delivery of the traditional approach and the proposed system.

Packet Delivery Ratio (Average)

Based on this benchmark, the traffic of the data set was set on all the network sets, which are three in number, and the traditional method was compared with the proposed algorithm model. The experiment outcomes are shown in Figure 5; additionally, the research outcomes show that the proposed algorithm outperforms the previous one.

Latency (Average)

The method was also calculated for the typical data transport latency with the compromised and malicious nodes. Comparisons were made between the traditional and proposed systems. The simulation outcomes demonstrate that the proposed algorithm's average latency is better than the traditional one. Figure 6 demonstrates the results:

The Average Efficiency of Energy

It is one of the most important measures to determine and check the average efficiency of the system. The simulation results show that the proposed system's average efficiency is higher than the traditional one. The results are shown in Figure 7.

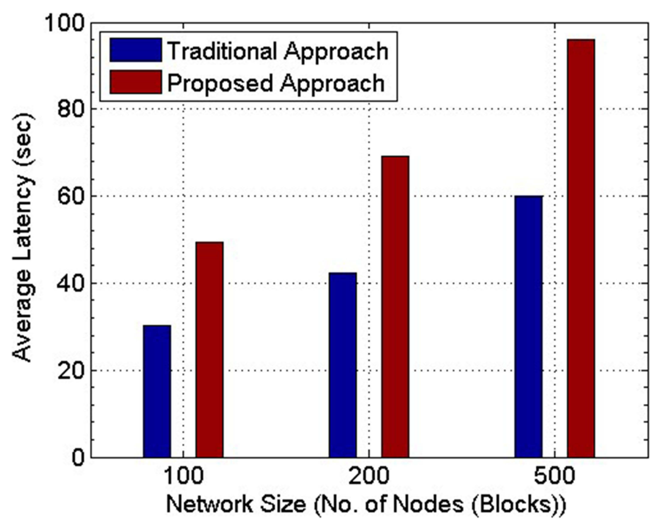

Figure 6 Depicts the average latency of the traditional approach and the proposed system.

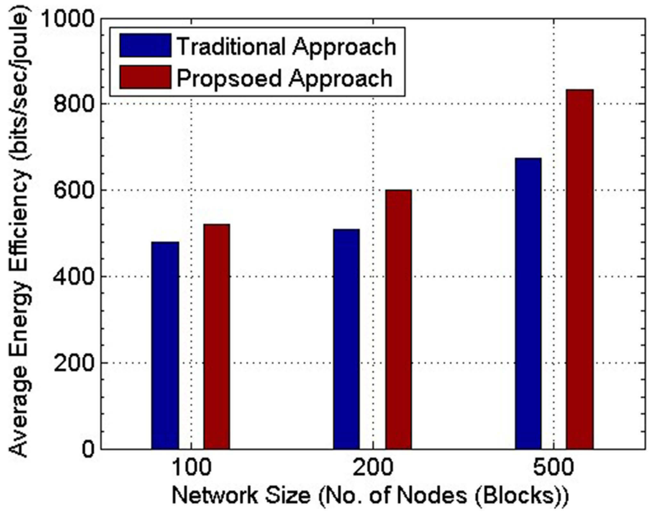

Figure 7 Shows the average energy efficiency of the traditional approach and the proposed system.

Discussion

As blockchain makes the process automatic, it makes the results faster and brings efficiency to the execution of data, storage, and data processing. Some are the necessary points have been mentioned while executing smart contracts which have been mentioned below:

- For the implementation of smart contracts, two models can be used. One model is based on the transaction where transaction execution is prioritized as input variables are fed. The other model is based on the account, controlled by the smart contract that supervises the possessions and deals with them on the blockchain. The smart contract outcomes be coded appropriately to become foolproof and reduce the possibility of a hung-up state.
- The smart contracts must be deterministic and objective, meaning they should provide the same set of output that has been given input.
- Every node can cross-check the transaction and system state to maintain consistency. As mentioned, once any transaction has been made, it cannot be reverted, making it tamper-proof. All the transactions have signed shreds of evidence, which means proof of who has done the transaction and when it is available.

Smart contracts are tamper-proof, self-verified code scripts can be independent, have automated procedures, and provide secured transactions. Removing the need for a third party and resulting in cost reduction. Using smart contract points, IoMT model in the e-healthcare system has been mentioned. The behavior of smart contracts is predictable, and they are entirely autonomous. Therefore, before the node gets engaged in any contract, the results and execution are clear. However, the main application comes from the network and must be independent and transparent. The third party currently validates such systems as a trusted source.

Also, the statistical analysis showed a significant relationship between the proposed hypothesis that illustrates parallel findings to the literature. Some researchers investigated the use of IoMT can improve the performance of e-healthcare. Two defined research groups have been analyzed to assess the intention of people experienced regarding the use of smart contracts. Blockchain can enhance security concerns, patient data protection, quick disease diagnostics, and less chance of data loss. Since blockchain records are immutable and verifiable, they can be examined and trusted immediately when employed in a healthcare system.

Conclusion

The study on using blockchain in e-healthcare has recently gained significant attention. The findings suggest that implementing smart contracts using blockchain technology can improve the IoMT in e-healthcare. The integration of the Internet of Medical Things (IoMT) into e-Healthcare systems has the potential to revolutionize healthcare delivery and outcomes. However, using IoMT can raise several key issues, such as security and privacy concerns, interoperability challenges, regulatory compliance, and data management and analytics. Blockchain technology can provide a solution to these issues, mainly through the use of smart contracts. By leveraging blockchain's decentralized and immutable ledger, healthcare organizations can enhance the security and privacy of patient data, facilitate interoperability between devices, ensure regulatory compliance, and automate and streamline healthcare transactions, improving efficiency and reducing costs. Thus, the impact of using IoMT and blockchain in e-Healthcare performance can significantly improve the quality of patient care, enhance healthcare delivery, and ultimately lead to better health outcomes. The study compared two groups, one using smart contracts with blockchain and the other without, and found that using smart contracts with blockchain technology was more effective in automating and improving health data management. The application of smart contracts in healthcare has the potential to enhance people's lives significantly. Emerging technologies such as cloud computing, mobile computing, big data analytics, AI, and physical and cyber systems can be integrated with blockchain technology for even more significant improvements. In some cases, a combination of AI, big data, and IoT may be necessary.

Future Recommendations

Based on current trends in e-healthcare and the Internet of Medical Things (IoMT), here are some future recommendations for research on the impact of IoMT on e-healthcare performance and how blockchain can assist in improving smart contracts. While there has been some research on the impact of IoMT on e-healthcare performance, there is a need for more empirical research that uses quantitative and qualitative methods to examine the impact of IoMT on various aspects of e-healthcare performance, including patient outcomes, healthcare costs, and healthcare quality.

Moreover, as IoMT devices collect and transmit sensitive medical information, there is a need to investigate the security and privacy concerns associated with their use. Future research should examine how blockchain can help to address these concerns and improve the security and privacy of IoMT devices. Smart contracts are a promising tool for automating and improving various aspects of e-healthcare, such as patient data management, clinical trials, and medical billing. Future research should focus on developing and testing new blockchain-based smart contracts that can address the unique challenges of e-healthcare and IoMT. Additionally, regulatory frameworks are crucial in shaping the adoption of IoMT devices and technologies. Future research should examine the impact of regulatory frameworks on adopting IoMT devices and technologies and the potential role of blockchain in facilitating compliance with these frameworks.

Data Sharing Statement

The datasets used or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

Ethical approval was obtained from the Hamdan Bin Mohammed Smart University Research Committee.

Consent to Participate

Informed consent was obtained from the study participants.

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