Perspective

Blockchain technology in healthcare strengthening: The Nigerian case

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Abstract
Blockchain technology is a distributed ledger digital system that records all transactions on a network of interconnected systems in a way that is impossible to edit or hack. When blockchain is mentioned, thoughts of cryptocurrency pop into mind, but blockchain holds vast possibilities in other facets, such as big data analytics, research, the Internet of Things, healthcare, etc. Blockchain technology has many practical applications in the healthcare sector, including precision medicine and interoperability, supply chain management, authorization exchange of health information, security, and authorization, all of which are pivotal for effective health systems and quality health services. Significant hindrances have been inadequate infrastructure, lack of funding, computer literacy, and poor government policies. The challenge of establishing blockchain technology must be addressed. Exploring its architecture in the Estonian healthcare-based system, the possibility of its deployment in the Nigerian health sector is feasible with the right approach and government policies. This perspective paper discusses the potential benefits of blockchain in the health sector, the obstacles that impede the adoption of this technology, and the recommendations to overcome them. It aims to create awareness and close the significant gap between this idea and its implementation in our healthcare system. This will ultimately improve patient outcomes and strengthen our healthcare planning and management system.
Keywords: Blockchain technology, Electronic health records, Health information management, Health policy, Health sector, Healthcare strengthening, Health systems, Nigeria

Introduction

First used with the introduction of the Bitcoin cryptocurrency in 2009 by Satoshi Nakamoto,[1] Blockchain—a type of distributed ledger technology (DLT)—is a digital system that records all transactions on a network of interconnected systems in a way that is impossible to edit or hack (inviolable). In a blockchain, transactions are organized into blocks and cryptographically chained in an immutable, interoperable, transparent, and secure manner to create an unalterable history.[2-4] Before Satoshi's Bitcoin peer-to-peer formula, a centralized arbitrator was required to police, plan, and monitor transactions between two parties. The primary use of blockchain technology upon the introduction of Bitcoin is the provision for decentralization rather than centralization, making it possible for transactions in a disseminated ledger between two parties with no involvement from a central third party, e.g., a bank or any other organization.[5]

Thoughts of cryptocurrency or bitcoin pop into mind when blockchain is mentioned, but blockchain holds vast advantages and possibilities in other facets but not limited to cybersecurity, electioneering process, insurance, government law enforcement, big data analytics and research, the Internet of things, and healthcare.[5,6] Its core features: immutability, transparency, security, and autonomy,[2] make it an essential tool for good management, and the supporting architecture of blockchain has an immense potential to transform healthcare and medicine.[4] Hence, integrating blockchain technology into healthcare could enhance growth in Nigeria. It has many applications in the healthcare sector, including precision medicine, supply chain management, health information exchange, security, and authorization. These applications have immense benefits for both the healthcare organization and the patients.[7]

In Nigeria, paper records dominate, and electronic records continue to be plagued by issues such as privacy, security, patient access to their medical records, etc. Blockchain technology consists of a secure, shared, and encrypted database that functions as an unalterable public repository for information, providing solutions to these challenges.[8] But how feasible is it to incorporate blockchain technology into the healthcare system in Nigeria? The information and communication technology (ICT) sector in Nigeria has recently become one of its most vibrant industries. With a high rate of internet usage and a significant number of ICT experts, Blockchain technology deployment in healthcare is feasible with the right approach and government regulations,[9] However,

there has been no significant move towards the adoption of this technology to meet global best practices for quality healthcare in Nigeria[10] because the challenge of establishing a disruptive and rapidly evolving technology like blockchain cannot be overemphasized especially for a low-income country like Nigeria; thus, there is a need to raise awareness about the benefits of this technology and the need for its implementation as soon as possible.

An overview of the Estonian blockchain-based healthcare system

Since 2012, Estonia has been utilizing blockchain technology. The Estonian government put its one million healthcare records on blockchain in March 2016.[11] With a triumph supported by international media coverage and top rankings on the European Union (EU) digital economy index, it is well known that Estonia is leading the world in creating a digital society.[12] The Estonian government runs an e-health foundation using the Keyless Signature Infrastructure (KSI) blockchain to obtain digital signatures. They do this in collaboration with a tech company called "Guardtime", and this company requires that users be authenticated before KSI services are rendered. The KSI system offers integrity checks and transparency by using signatures to monitor medical records etc.[13] The Estonian-developed KSI blockchain has been used to ensure that data systems, such as those about the country's national health, are kept 100% secure. Scalability, high cost, and low performance have been the major setbacks in implementing this promising technology. Still, according to Estonia, which has been able to implement this technology, KSI can handle 10^{14} signatures per second.[11,15] Although expensive, this is promising.

Benefits of blockchain technology in healthcare
Efficient record-keeping and retrieval

Blockchain technology is a dependable repository for information: As data from clinical services continue to increase, leading to information overload, access to patient records has become more complex and tiresome to store and retrieve on paper. With blockchain, the algorithm tags all information to be easily accessed when needed.[16] Most healthcare facilities in Nigeria rely on medical records stored on paper as medical files. This method of keeping patients' information is inefficient, wastes time to retrieve, is prone to destruction due to fire outbreaks and other hazards, is insecure in terms of privacy infringement, and could quickly go missing or to get mixed up, as has been recounted several times. This system has deterred numerous individuals from seeking adequate medical care across all levels of Nigerian healthcare facilities. As a result, many have turned to self-medication, which increases the risk of incorrect self-diagnosis, the concealment of serious illnesses, and the

potential for drug misuse.

Blockchain technology is suitable to address these challenges. It is designed to store continuous and lifelong records. These medical records could be accessed by healthcare providers anytime, anywhere, once connected to a network.[17] Integrating blockchain technology will minimize time loss and stress, thereby greatly motivating individuals to pursue appropriate medical care at certified medical facilities.

Patient profile privacy/security

Patient data stored on a blockchain has an immutable history. This provides security to the health data of the patient. The transparent and secure nature of blockchain technology creates an ambiance of trust when it comes to interoperability.[6] Because of the privacy and confidentiality concerns surrounding medical record keeping, the storage, and management of patients' medical records require a simple approach to authenticate and verify the patients' identity before gaining access to such records. For a system involving multi-participants, blockchain offers an efficient and protected data access management structure[18] in the form of passcodes, biometrics, etc. Hence enabling patients to be in absolute control of their health data[6] and be actively involved with decisions concerning them, such as using their data for research, surveillance, etc.

Supply chain management

Nigeria was ranked highly by Transparency International for corruption, which is undoubtedly one of the country's biggest problems.[19] The flow and storage of manufactured medical supplies from the suppliers to their destination, such as a pharmacy complex or hospital, is monitored by supply chain management.[20]

Supply chain management must concentrate on finding a solution to the issue of insufficient information on a product's transport history to improve product traceability and transparency and curb the obnoxious problem of substandard drugs, laboratory reagents, and other healthcare supplies.[21] Blockchain technology promises to offer a solution to this problem. Counterfeit supplies have dire consequences in that they do not only deprive consumers of their income; they also pose a significant health risk to patients that, in some cases, could prove fatal.[22]

Interoperability and precision medicine

Interoperability is simply the ability for two or more parties or institutions to share and use exchanged information.[23] In making a diagnosis, a patient's medical history plays a vital role in the physician's decision-making. Therefore, prompt and accurate health record information must be made easily accessible before medical decisions are taken. It is common for people to seek healthcare services in

different medical centers at varying times for reasons such as being away from their primary residence, proximity, and the varying cost of healthcare services amongst various medical institutions. This has left sections of patients' medical records scattered across different medical facilities. A study by Kombe et al[24] revealed how challenging it is to exchange patients' clinical records from one healthcare facility to another. This has resulted in physicians treating their patients without a complete grasp of the underlying medical condition or patients' allergies, culminating in misdiagnosis and, consequently, could lead to death. Also, invariable medical tests such as blood groups and genotypes that have been carried out elsewhere tend to be re-ordered by physicians [24] due to the lack of efficient and proper interoperability among health facilities, thereby incurring avoidable labour and financial cost.

Blockchain can facilitate precision medicine and/or personalized healthcare by enabling healthcare practitioners to share medical records and information to design and exchange patient-specific healthcare plans.[25] Blockchain guarantees a central database that healthcare providers can gain access to information from any town/city in the country via any electronic system connected to the internet while ensuring the desired privacy, low cost, and completeness of information.[26]

Public health surveillance and epidemiology
Since blockchain can handle electronic medical records (EMRs), it can be a powerful tool for reducing the impact of a pandemic. Researchers and professionals in public health now have straightforward access to recent data produced by numerous healthcare facilities spread throughout a particular geographical area because of the decentralized nature of blockchain technology. This real-time information might be used as an early warning system for pandemic isolation, detection, and containment.[27] However, if this data management system allowed a centralized authority to access the information held, it could become counterproductive. An effective blockchain technology was developed to address this problem by making user identification and location less private and sensitive, preserving existing data protection issues.[28]

Challenges to the implementation of blockchain technology in the Nigerian health system
Inadequate infrastructure and lack of funding
Inadequate infrastructure is the most critical issue that must be addressed to ensure successful adoption. Lack of funding, unreliable power supply, and network (Internet connectivity) problems are also crucial factors.[8,29] The performance and productivity of healthcare workers trained in the use of electronic equipment could be significantly increased if they had access to an improved, more comfortable working environment, complete with internet access and various communication tools.[30] In the United States and several developed nations, there is a solid commitment to fulfilling the goals associated with developing efficient information technology systems, notwithstanding setbacks. These countries invest significant funds into research and development of information systems designed to meet the requirements of their healthcare systems. The healthcare systems in many underdeveloped nations like Nigeria starkly contrast this. Implementing healthcare IT-based solutions in many countries is difficult because of insufficient funding and poor healthcare infrastructure.[31]

In developing nations, a sizable portion of the population lives in rural locations, and it is difficult to install e-health technologies physically. Similarly, Nigeria's unreliable power supply, including network outages or low coverage, may obstruct its deployment. Any nation that struggles to provide its residents with an uninterrupted power supply would undoubtedly struggle to deploy high-quality ICT services.[32]

Usability/computer literacy
Usability is also an issue because blockchain systems are so complex to operate. There is a need for an Application Programming Interface that incorporates user-centric features, ensuring usability. Since health professionals often possess varying degrees of technical expertise compared to IT specialists, the systems should prioritize simplicity and accessibility. Research by Sood et al. [31] deemed many clinical workers in underdeveloped nations as computer illiterate, examining the difficulties the healthcare workforce encountered in adopting EMRs. Research conducted in Ile-Ife, Nigeria, revealed that just 26% of health record officers had access to computers, and only a minority exhibited proficiency in computer usage and information technology.[33] Adult literacy rates in Nigeria are poor especially when it comes to computer literacy. As a consequence of various cultural considerations, it is likely that many consumers would reject blockchain or any alternative e-health applications, therefore many efforts fail after successful pilot programs; in many circumstances, relatively few start-up plans or ideas materialize.

Government policy and implementation
Due to challenges such as their failure to establish and maintain global health partnerships and their hesitation to allocate sufficient financial resources to health sectors, the commitment of most African leaders, including Nigeria, to healthcare remains inadequate.[34] Even when the policies are created, they are not well coordinated and tied to any specific economic goals.

The Nigerian government is alleged to have revamped its healthcare system delivery in Bamako's 1987 initiative.

However, little to nothing has been seen in incorporating ICT in its health sector since then. [32] Although there is legislation called the National Electronic Health Record Bill HB447, it recently passed a second reading and was submitted to the Healthcare Service Committee before the House of Representatives. The bill seeks to create a National Health Repository Service where health records of registered healthcare recipients are stored. The creation, implementation, monitoring, and assessment of healthcare policies have all suffered significantly due to political unrest and unstable economic climates.[35] Fundamentally, positive initiatives passing from an outgoing regime to the next tend to be discontinued or poorly realized by the new regime due to shifting political targets or a general indifference to the aims of the previous government. The Nigerian health system is below the World Health Organization standards because of the small fiscal allocation to the health sector. Inferentially, funding is insufficient and is not being delivered to healthcare facilities on time.[36]

Recommendations

With developed countries struggling to implement this technology, a developing country like Nigeria is still some distance away from adopting this technology due to poor-quality computing power, poor infrastructure, and general implementation cost and expertise to adopt, amongst other factors. Nigeria is plagued with related issues of medical data integrity and privacy, voluminous patient records, and poor supply chain management system,[8] hence, the potential blockchain technology offers in healthcare is too good to ignore. Little steps are essential for an optimistic future of a blockchain-driven healthcare system in Nigeria, and a few recommendations are provided below:

1. The best way to close the significant knowledge gap between this technology, its benefits, applications, and its implementation in the Nigerian health sector is to create increased awareness and sensitize the government to increase awareness campaigns. It can be inferred that there is a technology knowledge gap among healthcare researchers and even computer engineering experts, with the majority showing little to no understanding of blockchain.[31,33]

2. Other than the creation of a legal framework through legislation, rules, and regulations to accelerate the use of blockchain technology, government, universities, and other industries should initiate/fund a long-term research development and education program that features blockchain innovations to birth a future with high-quality, dependable computing power, expertise and communication systems, hence, carving a new career path in Nigerian universities/higher institutions.[8]

3. Outgrowing paper systems and integrating EMRs in preparation for a transition into blockchain technology. As unrelated as this may seem, starting with such a transition significantly closes the gap between paper systems and a blockchain-based medical record system.

4. Partnership and collaboration with experts from other countries: To develop a blockchain framework and further understand the underlying architecture that has proven effective for other countries, the government must partner with international blockchain experts in countries such as Estonia, Georgia, Singapore, etc.[8,37]

5. Electricity supply: The power supply issue should receive special attention, with the country's national grid collapsing many times in 2024 alone. Various means, such as solar panels and nuclear energy, are suggested to enhance the power supply.

Conclusion

Blockchain is an emerging technology used to proffer creative solutions in many industries, including healthcare. In the healthcare system, it has the potential to revolutionize the way information is stored, accessed, and shared. Investigations on the use of blockchain in healthcare continue to grow even though many limitations still surround its use. Further studies and research are required to address scalability issues and a more feasible prototype with a realistic cost of implementation. Although the chances of implementing blockchain technology immediately in Nigeria are slim, there is a need for a greater public awareness of its benefits and the challenges of implementing this promising technology in our healthcare system. By discussing these, this perspective piece aims to create awareness and close the wide gap between this idea and its implementation in our healthcare system.

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