# Towards Development of a Blockchain Based Healthcare Management System in Pakistan

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**Summary**

In developing countries like Pakistan, generally healthcare sector faces a lot of challenges. Because of unavailability of a systematic mechanism stakeholders involved are not integrated into a single system for effectiveness. In this work, we have shown the potential of creating a Blockhchain based system for better healthcare management in Pakistan. It is an emerging technology with diversified applications. A literature review has been done regarding healthcare management using Blockchain technology in general in addition to general review of the current situation of healthcare sector in Pakistan. Based on this, a discussion has been provided as guideline for development of Blockchain based system for Pakistan. Stakeholders necessary for development of such system have been identified. Advantages and areas to address have also been highlighted. Future directions helping in development of such system are also part of the paper.

***Key words:***

*Blockchain, healthcare, patient, Pakistan*

## 1. Introduction

Blockchain (BC) technology has been developed in 2008 by Satoshi Nakamoto and was basically used in Bitcoin application as Cryptocurrency [1]. BC is considered a secured database which is a distributed one as well as shared. It is used to keep record of list of records constantly occurring viewable and accessible to all with equal authenticity and without third party intervention. The term Block is used for these transactions [2].

It can be said that BCs has been mostly applied in financial industry, however, there are many other applications that use BC technology. Examples include healthcare, insurance, pharmacy, manufacturing, e-voting, and many others. Healthcare sector is considered a growing area of BC application. Applying BC in healthcare serves to improve patient care [1].

This research investigates the potential of a BC system in healthcare sector of Pakistan to result in better patient's healthcare management. In Pakistan, generally medical health record assurance is relatively on lower side. Therefore, there is need to consider emerging technologies like BC to overcome the difficulties faced by the healthcare sector and to develop a secure, reliable and accessible system for patient satisfaction as well as overall improvement of healthcare management in the country.

The paper is distributed in the manner that Section-2 describes the background information related with BC technology. It is followed by Section-3 which provides a review of application of BC technology in general in healthcare sector and in Section-4, a literature review regarding healthcare management scenario of Pakistan has been provided. Section-5 provides a discussion towards use of BC technology for healthcare management services in Pakistan with a number of stakeholders identified for this purpose. It also includes discussion regarding areas to focus while developing BC system, its advantages and grey areas to address. Finally Section 6 provides conclusion and future directions of this work.

## 2. Background of Blockchain

The term Block Chain (BC) has two distinct terms "Block" and "Chain". Blocks are basically used to store data. These blocks are joined together to form a chain. It can be said that these blocks are interlinked and constitutes the BC. When more and more transactions are added in the chain, the chain starts to increase. The core of BC is that no central authentication mechanism exists. In fact, all records entered as transactions are distributed to all in the network. Therefore, it reflects a distributed database. In BC technology, a moderator or manager or middle man role is eliminated which means that all stakeholders in the chain have equal status and this is regarded as beauty of BC technology. BC holds the records of all transactions and they in general cannot be deleted by a single stake holders. In this way BC provides a highly secured network [1]. BC is generally categorized into two categories called public and private. Public BCs are available on Internet and are publically accessible to all. An example is bitcoin or cryptocurrencies. Private BCs use BC based platforms for creating block chains. Examples include Ethereum or Blockchain-as-a-service (BaaS) platforms which runs on a private cloud infrastructure. In can be said that Public BC belongs to the category of Internet whereas Private BC belongs to the category of Intranet. Besides that, a

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consortium BC is considered as integration of public and private BC and is partially decentralized [3]. The reliability factor along with authenticity and accuracy of types of BC is still an ongoing process. Some of the key features of BC technology are described below [4]:

### 2.1 Blockchain as Distributed Database

Each stakeholder in BC has control over entire database and its complete history. No single stakeholder controls the data or the information. Every stakeholder has authority to verify the history and transactions of activities inside BC without an intermediate involvement.

### 2.2 Peer-to-Peer Transmission

BC is an example of Peer to Peer transmission. In transmission, all transactions occur between stake holders also called nodes. There is no centralization involved and each stakeholder has equal status. All stake holders are senders and receivers for all other nodes or stakeholders.

### 2.3 Transparency

In BC, transaction occurs between BC addresses. Generally, each node associated with BC has a unique 30 or more character based alphanumeric address. Whenever a transaction takes place in BC, it immediately becomes available to every stakeholder who is part of chain. In this way, BC ensures transparency.

### 2.4 Irreversibility of records

Another key feature of BC is the irreversibility of records or transactions becoming part of BC. Records are of high importance in BC system as they are irreversible once entered and they become a part of link in terms of their position based on transactions that have occurred before them or would occur after them. That is why the term Chain is used in BC. Different methods, algorithms are used to ensure that irreversibility of records is maintained in BC.

## 3. Application of Blockchain in Healthcare Sector

In the literature, A. Azaria et al. [5] have developed a BC based system called MedRec to deal with Electronic Medical Record (EMR) of patients. MedRec was not used to store health records. Rather a signature was used to notify the patient that an unaltered copy of record has been obtained. Patient remains in control of the travel path of the data.

A. Theodouli et al. [6] developed a system for healthcare data sharing and permission management using BC technology. Security and integrity of data was ensured in the system. The proposed system added values various areas including data integrity, patient pseudonymity, automation of workflow and audit process. They concluded that the BC technology based systems like the developed one would have an impact on medical research innovation.

A.Rajeb and L. Bell [7] have presented a case study of Tunisia regarding implementation of BC technology in healthcare sector. They have highlighted that for practical implementation of BC technology, Government is required to take steps for training, funding and also for regulations in the form of frame work for adopting BC technology in healthcare.

K.A. Koshechkin et al. [8] have discussed the scope of BC technology in healthcare sector for Russian Federation. They highlighted that pilot projects are going on in Russian Federation using BC technology in healthcare sector. They also suggested that BC technology can also be used for Telemedicine application. They also added that the use of closed BC technology would increase the legal significance of electronic information and would also increase quality of public services in electronic form.

Y. Chen et al. [9] proposed a model based on BC technology in combination with cloud computing for storage of personal medical data of patients. The system did not involve any third party interference as well as no single node of the system had absolute authority in the system thus meeting the requirement of BC concept.

A systematic review by F. Casino et al. [10] has shown that Electronic Health Record (EHR) has strong potential for BC technology where patients may access and maintain their healthcare data while simultaneously ensuring security and privacy. The authors have also shown in review that number of publications specially conference papers are on the rise implementing BC technology in various areas including healthcare.

B.A.Tama et al.[11] have done a critical review of BC technology and its application in various fields. Regarding healthcare applications, they have shown four studies namely Healthcare data gateway (HDG), MedRec, Pervasive Social Network (PSN) based healthcare network and blockchain-based access control mechanism (BBDS). They argued that managing healthcare data, i.e. acquiring, storing, and analyzing is considered a complicated task and also privacy issues need to be considered in BC system for dealing with any frauds expected to occur in the system.

In a recent Systematic literature review by H. Hussien et al. [12] on application of BC technology in healthcare sector, authors initially screened 472 papers and after thorough filtration performed the review on 58 papers. In the review, it can be seen that number of publications regarding development of BC based system in healthcare sector are rising and more researchers are focusing on this area. Authors also have recommended to use private or consortium BC system for healthcare management as in case of Public BC system, permissionless mechanism may

result in chaos and inefficient system. The authors concluded that BC is an emerging technology and there is need of further investigation and to address limitation of the technology.

## 4. Literature Review of Healthcare Sector of Pakistan

In Pakistan, generally there are various aspects of issues related with healthcare sector.

In a study by A.Ahmed et al. [13], it was found that Pharmacy activities in Pakistan lacks proper training, and are also overburdened. The situation is worst in rural areas In this regard. Healthcare sector of Pakistan has multiple units. Primary Health Units (PHUs) consist of Basic Health Units (BHUs) which provide initial treatment to the patients. The term Rural Health Units (RHUs) is used for rural health centers. Sub district population benefit from Tehsil Headquarter Hospitals (THQs). It is followed by District Headquarter Hospitals (DHQs) which are larger centres and have multiple facilities to deal with complex cases. The role of Pharmacists is of utmost importance especially for DHQ hospitals. They can provide guidelines and scrutiny checks for prescribed medicines.

In a recent study by R. Hussain et al. [14], it was suggested that there is a wide scope to improve healthcare facilities especially in the area of Primary health care in Pakistan. It was also enlightened that it also depends on various factors including geographical access, other socio economic factors, cultural aspect and others. Other imported area highlighted was unavailability of medicines and Doctors.

A. Haseeb et al. [15] conducted a study for the patients of rural areas outside Karachi, a mega city of Pakistan, it was found that self medication by the patients is high (85%). The reasons identified were cost of consultation and availability of medicines. Pharmacies in Pakistan in general provide medicines without prescriptions. The study also found that data about rural areas of Pakistan in this regard was not available. The limitation of the study was that it was restricted to one rural area of Pakistan and complete generalization was not possible.

In a research conducted over 16 pharmacists of Pakistan by M.S. Khan et al. [16], it was found that significant gap occurs between patient, pharmacists and Doctors and there is need to find ways and methods to reduce the gap regarding drug information sharing for quality patient handling.

M. Bilal et al. [17] conducted a research in Rural Sindh province of Pakistan to investigate the use of Antibiotics in self-medication among population. It was found that 81.25% of population under study used antibiotics being on self-medication. The major cause identified was economic reasons. The authors emphasized the need for creation of laws to prevent this trend. Availability of medicines without prescription on medical stores was another strong reason. The limitation of study was that it was restricted to only Sindh province of Pakistan.

In another study by M.M. Aziz et al. [18], it was found that in certain cases, medicines are not available in Pharmacies in Pakistan, and because of lack of guidance to the patients, finding alternative medicines is an issue as well. Authors suggested that legislation and proper vigilance among various other remedies are required to deal with the problem.

In another research by S.A. Javed et al. [19], patient's satisfaction in public and private sector in Pakistan regarding health care sector was discussed through surveys. The results revealed that two important criteria for patient's satisfaction include reliability and responsiveness. The results also showed that in comparison to public sector, patients in Pakistan generally are happier by Private sector. A limitation of the study was absence of cost analysis which is expected to provide variance in results.

Prescription error is also a common area of concern in Pakistan. A study done by S. Khattak et al. [19] in Khyber Pakhtunkhwa (KPK) province of Pakistan based on 150 prescriptions collected from different areas of province showed that 88% were due to incorrect prescribing of dose by the doctor. Others factors included were inadequate information provided by the patient or pharmacist and incorrect use of medicines. The authors stressed on the training and supervision for safe prescribing of medicines. This can result in suffering for patients. These findings were also in correlation with other studies previously done in this regard.

In another study by A. Sharif et al. [20] done on cross sectional assessment of patient satisfaction with pharmacy for public healthcare sector in Quetta city of province Balochistan of Pakistan, it was discussed that as the Quetta region has multi lingual environment, therefore, knowledge of more languages may help in obtaining better result from pharmacies because of better communication.

We can conclude from the literature review that in healthcare sector in Pakistan, Doctors, Pharmacists and Patients are key stakeholders. It was observed in the literature review that prescription errors can occur by Doctors. Pharmacists require more training and guidance to deal with the specific problems of patients. This can include selection of alternative medicines if required, guidance regarding use of medicines and providing overall description for patient satisfaction. Patients have a lot of diversity in Pakistan. Because of education, financial resources, availability of health services, difference between urban and rural class, hence criteria for patient satisfaction varies. As reported in [20], even languages can play an important role in patient satisfaction. Unavailability of research done on uniform criteria for all Pakistan was not available and nearly all the studies have indicated their limitation confined to a specific region, or province.

Therefore, there is need to devise a mechanism based on modern technologies for the development of a framework that can address key issues in healthcare sector. BC technology may play an important role for such development. The ultimate goal is to have a reliable healthcare management system for Pakistan where patient satisfaction is achieved based on quality of health care service provided.

## 5. Scope of Blockchain for Healthcare Sector in Pakistan

BC technology has high potential for population of developing countries. The percentage of people having internet access in developing countries in general is on the rise which is an indicator that technologies like BC would be accessible to majority of population in future [21].
Pakistan is in the process of using BC technology in different fields. For the first time, Government of Pakistan has used BC technology in the banking sector for secure money transfer [22]. It is expected that it would be implemented in other areas of public interest as well. In this continuation, healthcare sector has strong potential for the use of BC technology and Government of Pakistan is expected to play a vital role as healthcare management across the country is among the necessities any Government strives hard to provide to its citizens.

### 5.1 Discussion towards Development of BC System

There is need to do a detailed study across the country or a single province to find out the stakeholders of health care management system. It is emphasized that for initial development of a pilot BC system, only key stakeholders need to be considered. Other related stakeholders or data can be included later on once initial results are obtained from the system. On the basis of our review, following stakeholders are suggested as listed in Table 1:

Table 1: Stakeholders initially selected for BC System

| S. No | Stakeholder | Priority |
|---|---|---|
| 1 | Doctor | High |
| 2 | Healthcare centre Incharge/ Hospital Incharge | High |
| 3 | Pharmacist | High |
| 4 | Patient | High |

It can be seen from Table 1 that four stakeholders are defined. S No 1, 3, 4 are selected in line with literature review. As we have seen that Doctors also have a chance of error while examining a patient and recommending medicines, therefore, Health Care Centre Incharge/ Hospital Incharge would also be included in the chain so that he/she overviews the prescription given by the Doctor. This is especially important in case of Pakistan as generally public sector Doctors remain very busy and therefore, chances of errors increase. This would ensure a countercheck mechanism to remove critical errors. Patient is a key stakeholder and the system would ensure patient satisfaction. Pharmacist is also a main stakeholder and an integral part of chain. All four stakeholders are of high priority. Platforms like Ethereum may provide an environment with complete programming language structures used for decentralized applications and can be used during development of BC based system. Other platform options are Hyperledger, Fabric, Stellar, NEO, etc. Concept of Smart Contracts can also be used for increasing system efficiency.
Once the patient sees a Doctor, an Identification (ID) would be created by the Doctor and all diagnosis information, medication prescribed would be recorded. Once entered, the information would be available to all stakeholders. Once all stakeholders provide an agreement, medicines would be issued by the Pharmacist to the patient. The following are the advantages of the system by keeping Pakistan under consideration:

1. Patient would be able to have confidence on the system by having authority to show his consent on prescription. In this way patient would visit only a reliable Doctor or in emergency cases would agree to the recommendation of the available Doctor.
2. Patient would have the confidence that agreement of Healthcare sector Incharge/Hospital Incharge is also part of the Chain. So in case of any critical error, healthcare sector Incharge/ Hospital Incharge can show his disagreement thus stopping the chain
3. Pharmacist would be able to have an overall impression of the patient disease and medication prescribed. As it has been a case in Pakistan that untrained Pharmacists generally do not provide satisfactory information to the patient. With the help on training given on the system, Pharmacist would be able to provide relevant guidance efficiently thus meeting patient satisfaction
4. BC system would help in minimizing catastrophic errors by any of stakeholders because of visibility of chain data

Following are general areas to be considered during the development of the proposed system:

1. BC is highly dependent on users and that is why risk factor is high. If incorrect information remains in the system then the performance of the whole system would be compromised. Education is the key factor that would help in creating a reliable BC based system.
2. An area of concern with BC technology is the latency issue. As agreement is required by all stakeholders alongwith security, it may take more

time for a transaction to be approved. There is need to develop frameworks to deal with this

3. To create a faster BC system only index information of medical data and transaction records are considered to be saved using BC system. Large medical data needs to be encrypted and saved outside BC.

## 6. Conclusion and Future Work

In the current work, we have provided a brief overview of the use of BC technology in healthcare management in general and with a specific focus on Pakistan. Literature review has shown that emerging technology of BC has been an active area of research and different BC based models have been developed for healthcare management. It has been shown that Pakistan generally lacks a healthcare management system based on Patient satisfaction. Automated system might help in resolving this issue. BC technology has strong potential in this regard. Keeping in view scenario of Pakistan, four active stakeholders for the development of BC based system have been identified and advantages and concerns regarding development of BC system have been discussed. In future, we would work for the detailed model based on BC technology for healthcare sector of Pakistan. Furthermore, Internet of things (IoT) is a fast growing area. It is estimated that in 2020, estimated 20.4 billion devices would be connected through this technology. One of the application areas of IoT is health care sector [23]. Combination of BC technology with IoT for healthcare sector of Pakistan is also a research area we aim to investigate. Telemedicine is another potential area we envisage to investigate in combination with BC technology [24].

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## References

[1] M. N. O. Sadiku, K. G. Eze, and S. M. Musa, "Blockchain technology in healthcare," Int. J. Adv. Sci. Res. Eng., vol. 4, no. 5, pp. 154–159, 2018, doi: 10.31695/ijasre.2018.32723.

[2] M. Iansiti and K. R. Lakhani, "The Truth About Blockchain," Harvard Business Review, no. February, 2017.

[3] D. Puthal, N. Malik, S. P. Mohanty, E. Kougianos, and G. Das, "Everything you Wanted to Know about the Blockchain," pp. 1–9, 2008.

[4] W.-T. Sai and R. Blower, "A System View of Financial Blockchains," in IEEE Symposium on Service Oriented Systems Engineering, 2016, pp. 450–457.

[5] A. Azaria, A. Ekblaw, T. Vieira, and A. Lippman, "MedRec : Using Blockchain for Medical Data Access and Permission Management," in 2nd International Conference on Open and Big Data, 2016, pp. 25–30, doi: 10.1109/OBD.2016.11.

[6] D. T. A. Theodouli, S. Arakliotis, K. Moschou, K. Votis, "On the design of a Blockchain-based System to facilitate Healthcare Data Sharing," in 17th IEEE International Conference on Trust, Security and Privacy in Computing and Communications/12th IEEE International Conference On Big Data Science And Engineering (TrustCom/BigDataSE), New York, NY, 2018, pp. 1374–1379.

[7] A. Rejeb and L. Bell, "Potentials of Blockchain for Healthcare : Case of Tunisia," World Sci. News, vol. 136, no. October, pp. 173–193, 2019.

[8] K. A. Koshechkin, G. S. Klimenko, I. V. Ryabkov, and P. B. Kozhin, "Scope for the Application of Blockchain in the Public Healthcare of the Russian Federation," Procedia Comput. Sci., vol. 126, pp. 1323–1328, 2018, doi: 10.1016/j.procS.2018.08.082.

[9] Y. Chen, S. Ding, Z. Xu, H. Zheng, and S. Yang, "Blockchain-Based Medical Records Secure Storage and Medical Service Framework," J. Med. Syst., vol. 43, no. 5, 2019.

[10] C. P. Fran Casino, Thomas K.Dasaklis, "A systematic literature review of blockchain-based applications: Current status, classification and open issues," Telemat. Informatics, vol. 36, pp. 55–81, 2019.

[11] B. A. Tama, B. J. Kweka, Y. Park, and K. Rhee, "A Critical Review of Blockchain and Its Current Applications," in International Conference on Electrical Engineering and Computer Science (ICECOS), 2017, pp. 109–113.

[12] H. M. Hussien, S. M. Yasin, S. N. I. Udzir, A. A. Zaidan, and B. B. Zaidan, "A Systematic Review for Enabling of Develop a Blockchain Technology in Healthcare Application: Taxonomy, Substantially Analysis, Motivations, Challenges, Recommendations and Future Direction," J. Med. Syst., vol. 43, no. 10, p. 320, Sep. 2019, doi: 10.1007/s10916-019-1445-8.

[13] A. Ahmed, M. Tanveer, A. Siddiqui, and G. M. Khan, "Bridging the Gap for Clinical Pharmacist in Developing Countries like Pakistan," J. Coll. Physicians Surg. Pak., vol. 28, no. 3, p. 229—232, Mar. 2018, doi: 10.29271/jcpsp.2018.03.229.

[14] R. Hussain, A. Rashidian, A. Hafeez, and N. Mirzaee, "Factors Influencing Healthcare Seeking Behaviour At Primary Healthcare Level, In Pakistan," J. Ayub Med. Coll. Abbottabad, vol. 31, no. 2, pp. 201–206, 2019.

[15] A. Haseeb and M. Bilal, "Prevalence of using non prescribed medications in economically deprived rural population of Pakistan," Arch. Public Heal., vol. 74, no. 1, pp. 1–7, 2016, doi: 10.1186/s13690-015-0113-9.

[16] M. S. Khan, S. Mehsud, and R. Dar, "A qualitative evaluation of new emerging role and challenges for community pharmacist in Pakistan: A case study report," African J. Pharm. Pharmacol., vol. 11, no. 21, pp. 266–270, 2017, doi: 10.5897/ajpp2017.4754.

[17] M. Bilal et al., "Self-medication with antibiotics among people dwelling in rural areas of Sindh," J. Clin. Diagnostic Res., vol. 10, no. 5, pp. OC08-OC13, 2016, doi: 10.7860/JCDR/2016/18294.7730.

[18] M. M. Aziz et al., "Patients' anticipation for the pharmacies of rural communities: A qualitative study from Pakistan," Int.

J. Environ. Res. Public Health, vol. 16, no. 1, pp. 1–14, 2019, doi: 10.3390/ijerph16010143.
[19] S. A. Javed, S. Liu, A. Mahmoudi, and M. Nawaz, "Patients' satisfaction and public and private sectors' health care service quality in Pakistan: Application of grey decision analysis approaches," Int. J. Health Plann. Manage., vol. 34, pp. 168–182, 2019.
[20] A. Sharif et al., "A cross-sectional assessment of patient satisfaction with pharmacy performance attending a public healthcare institute of Quetta city, Pakistan," J. Public Health (Bangkok)., Jun. 2019, doi: 10.1007/s10389-019-01100-5.
[21] N. Kshetri and J. Voas, "Blockchain in Developing Countries," IT Prof., vol. 20, no. 2, pp. 11–14, Mar. 2018, doi: 10.1109/MITP.2018.021921645.
[22] P. T. Website, "Pakistan deploys blockchain technology to counter money laundering," 2019. [Online]. Available: https://www.pakistantoday.com.pk/2019/01/09/pakistan-deploys-blockchain-technology-to-counter-money-laundering/.
[23] N. J. Atia Javaid, Maheen Zahid, Ishtiaq Ali, Raja Jalees Ul Hussen Khan, Zainib Noshad, "Reputation System for IoT Data Monetization Using Blockchain," in Advances on Broad-Band Wireless Computing, Communication and Applications, 2020.
[24] A. Z. Shaikh and L. Tamil, "Cognitive Radio Enabled Telemedicine System," Wirel. Pers. Commun., vol. 83, no. 1, pp. 765–778, 2015, doi: 10.1007/s11277-015-2423-1.