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An Empirical analysing the Critical Determinants of Implementing Blockchain Technology in Enhancing the Health Care Services using Management Activities

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ABSTRACT
Blockchain technology is one of the effective technologies that can help to make data management more secure, equitable as well as transparent. It has been used most commonly in the health-care domain to refer to electronic health records. Blockchain provides substantial benefits in spreading data access, control, along with ownership to end users, in addition to securely managing data. The most significant advantage of Blockchain technology is that it can improve the connectivity of healthcare databases, device tracking, allowing for greater access to "patient medical records", hospital assets, prescription databases, as well as the entire life cycle of a device within the "blockchain infrastructure". In order to collect data for this research, 53 healthcare stuffs are selected randomly to collect their responses about the benefits of blockchain technology in increasing healthcare services. The main aim of this study is to critically analysis of implementation of Blockchain Technology to uplift health care services such as patient care along with database management security by using management activities. Besides, multiple layers of verification are not required for "blockchain healthcare systems", and everyone who is a part of the blockchain architecture has access to data. For users, data is made accessible and accessible. These qualities can assist in resolving the different issues that the healthcare sector is now facing.
Keywords: *Blockchain technology, healthcare services, technology, Hashgraph, Artificial Intelligence*

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INTRODUCTION

The Blockchain idea has been introduced in the healthcare system through the bitcoin system. Primarily, blockchain was used to power bitcoin; however, due to its security and privacy strength on data storage, the technology has arrived in healthcare management as well [1]. Blockchain is used for storing clinical data, analysing them and evaluating sensitive data. In recent days, digitalisation has taken place due to its simplicity in data storing, data analysing and enhancing treatment. The patient data can be collected through mobile phones, iPads or computers and then can be stored easily using digital technology [2]. After that, the data are processed using different Artificial Intelligence (AI) approaches to bring an insightful result. Several studies have suggested that using these technologies, treatment facilities became better and clinicians received a scheduled treatment which reduced their psychological pressure [3]. Scheduling includes, the doctors being notified before surgery or training and so on. Therefore, digital technologies have truly benefited several healthcare management activities. However, besides these advantages, certain challenges are appearing as well. The challenges are security and privacy issues when digital technologies are used for managing sensitive data. Reports suggest that, in 2017, more than 300 security breach cases occurred and the security issues are increasing day by day. Thus, researchers have focused on *blockchain technology* to manage clinical sensitive data [4]. This blockchain technology has

allowed the healthcare management system to secure data during sharing by complying with privacy laws. Blockchain in healthcare management is categorised into three taxonomies: Private, public and consortium blockchain. The public blockchain is open to all, private blockchain requires specific permission to gain access and the consortium is semi-private where both public and private accesses are allowed as per the requirements [5]. This research has focused on the current blockchain technologies and their taxonomies to identify which blockchain is used in the healthcare management system and which is more secure. Primary survey-based research has been conducted with random healthcare staff to identify the practical scenarios of blockchain technologies in the healthcare sector.

In order to analyse the effectiveness of blockchain technology in healthcare services the research primarily focused on various implementations of blockchain technologies. Healthcare industries are currently using various management activities to increase the efficiency of healthcare services. Blockchain technology plays a significant role in developing the system of healthcare management. It is beneficial for the centralization of third-party applications. It can process more transactions individually or without third party authorities. Blockchain technology refers to keeping an immutable record of the chain transactions processed by the healthcare organization. It keeps the record of every transaction of one chain to another to hold the activity together [6]. Moreover, *Cryptographic keys* help to connect all the chain activities and keep them up to date by copying the blockchain activities.

Apart from this, implementing blockchain technologies ii the healthcare management has several effective advantages that include, *tamper-resistant nature, decentralized nature, digital ledgers* etcetera. Blockchain technologies have several key concerns that maintain health care activities. *Security of network infrastructure, identity verification, authentication of participants, accessing electronic information* etcetera, these are some key cancers of blockchain technology [7]. This particular technology can be applied in various health care aspects such as transactions, security, maintaining chain activities etcetera. Although, public blockchains are not being used to record public healthcare data or private information. It protects health care data by considering privacy issues. Blockchain technology is beneficial for the healthcare system to manage raw information and connect all the block activities [8].

Moreover, blockchain technology is relevant to traditional healthcare methods and management systems. It includes *decentralized management, unchangeable database, data provenance, robust data, traceable data, availability of the user* etcetera. These are some relevant activities of blockchain management and traditional health care systems. Blockchain management has several effective areas in healthcare applications to manage healthcare activities. These primary areas include *Managing electronic medical record (EMR) data, healthcare data protection, data management, genomics management, data management of electronic healthcare records*[9].

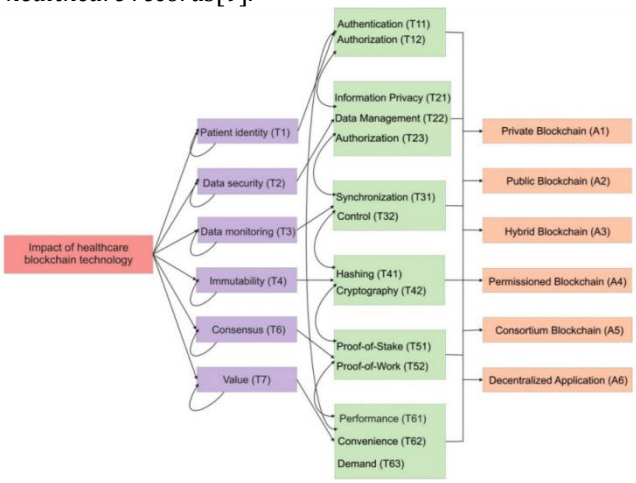

Figure 1.Blockchain in healthcare[9]

Blockchain technology is usually used to make the information recorded that cannot be changed or modified. However, the usages of blockchain have been used with securing personal information, voting, financial exchanges, and many more. Here in this context of healthcare management blockchain technology can also be used with the full application to make the information secure and unchanged [10].

It has been seen that the matter of accessing health issues by the doctors is well. however, the question of authenticity comes with the medicines. The medicines that have been recommended by the doctors get changed after the next visit and that creates consistency. In this context, the patients can have such issues of reliability that can create chaos in the industry. The benefits of implementing blockchain technology in healthcare services have been mentioned below.The tech blockchain is known as the most secure from getting threatened by outside, the technology creates multiple copies of the data that has been injected

into the data file. The process of creating multiple copies of the data can keep the information the same. In this context, ***Blockchain*** can be used to keep patient data safe and unchangeable [11].

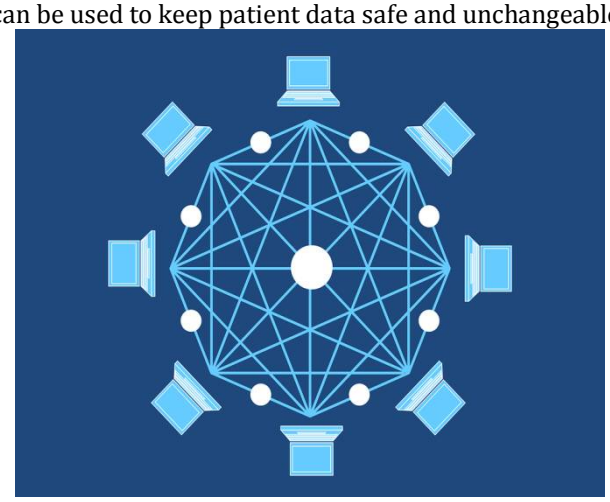

Figure 2.Blockchain Diagram[11]

The above images have been attached to understand the aspect of blockchain tech and to get the ultimate facts. As it has been mentioned before the technology of ***Blockchain*** is mainly used to keep data and information more secure than the other system [12]. The issues that have been seen internationally are on the aspects of reading past diagonal data of the patients. At the time of accessing patients, the past data of medical recommendations need to be evaluated before approaching a new prescription [13].

The above image has been attached to have a standard idea of blockchain tech with a graphical demonstration. In such huge hospitality management needs excellent data management for the patients. In this context, the kind of medical data that the experts need to access to recommend the patient for the next prescription is important to determine the past data of the patient. Multiple cases have proven that there is a lack of recording medical data of the patients that have been affected the most at the time of urgent diagnosis [14].

MATERIAL AND METHODS

Primary quantitative research has been selected to conduct the preliminary analysis with 53 random healthcare staff. The healthcare staff were selected from social media. Previously, the researcher uploaded a survey-based post on Facebook, Twitter and WhatsApp status where the healthcare professionals were targeted to answer a few survey questions. Various healthcare staff commented to fill the survey form. Thereafter, based on the diversity in healthcare sectors, 53 respondents were selected and asked to provide their personal email ID. The personal email ID was collected and a Google survey form was distributed. The Google survey form consisted of different questions related to the benefits, security, challenges and types of blockchains used in their respective healthcare sector. Apart from their knowledge in blockchain in healthcare data management, a few personal information was collected as well which include years of experience, name and age. However, this information seems to be irrelevant for this current study and thus, have been excluded from the analysis. The demographic data are useful in terms of identifying personal scenarios; however, in the case of blockchain technology, only blockchain knowledge will be enough for the final justification.

The survey data have been collected from the google survey where 53 respondents provided their responses to the questions. The questions contained 3-5 options and respondents selected the most promising option. After providing the responses, they submitted the Google form and the researcher collected the information in Microsoft Excel. The researcher then organised the survey questions and responses in Microsoft excel and analysed the percentile value. The percentile value will be analysed by the purposive sampling technique. This technique allows the researchers to draw their own judgements based on preliminary quantitative or qualitative data [15]. In this research, the primary data are quantitative where percentile values were analysed and evaluated based on the judgements of the researcher. During the judgements, secondary research has been conducted to support or counter the judgements. Secondary research has been conducted using the available online journal articles belonging to the last five years (2018-2022). Research belonging to the last five years contains recent information which will bring an updated discussion for this paper.

Besides the responses and percentile value, graphical representations have been generated as well to visualise the entire paradigm. The graphs were generated using Microsoft Excel. During the google survey form development, various research questions were generated by considering empirical analysis and

based on that, the survey questions were developed. The survey questions are placed under some broad research questions which are following.

Research Questions

What is the most used blockchain technology in healthcare sectors?
Which blockchain taxonomy is most secure?
What alternative technologies can be used to replace the conventional blockchain?
What are the limitations of blockchain technology?

RESULTS

The survey questions and their respective responses have been analysed below. A total of five relevant questions have been selected for further justification and from those, the percentile values were analysed.

Q1: Does your healthcare sector use blockchain technology for securing, sharing and storing sensitive clinical data?

Responses

TABLE 1. RESPONSES OF SURVEY QUESTION 1

Options in the Google Form	Total Respondents	Collected responses	Percentile
Yes	53	18	34%
No	53	35	66%

Table 1 survey responses (figure 1) showed that most of the healthcare sectors do not have the blockchain technology for storing, securing and sharing medical data. 66% of respondents stated that their healthcare sectors do not possess blockchain technology which suggests the technology is new to everyone and proper training with knowledge is required before the implementation. 34% stated their sectors have the blockchain which will provide a practical scenario on this concern.

Q2: Which blockchain taxonomy do you think is mostly used in your healthcare sector?

Responses

TABLE 2. RESPONSES OF SURVEY QUESTION 2

Options in the Google Form	Total Respondents	Collected responses	Percentile
Private blockchain	53	19	36%
Public blockchain	53	25	47%
Consortium (semi-private) blockchain	53	7	13%
Hybrid blockchain	53	2	4%

Responses to the second survey question (table 2, figure 3) showed that in the sectors where blockchain technology is used, public blockchain is mostly used (47%). The private blockchain is used as well in the healthcare sectors (36%), probably for transferring more sensitive data and confidential financial data. Besides these, consortium and hybrid blockchain are used. Studies suggest that consortium and hybrid blockchain are the same and used during the business development of healthcare management systems [16]. Therefore, a total of 17% of respondents agreed that hybrid blockchains are used; however, mostly public blockchain technologies are used.

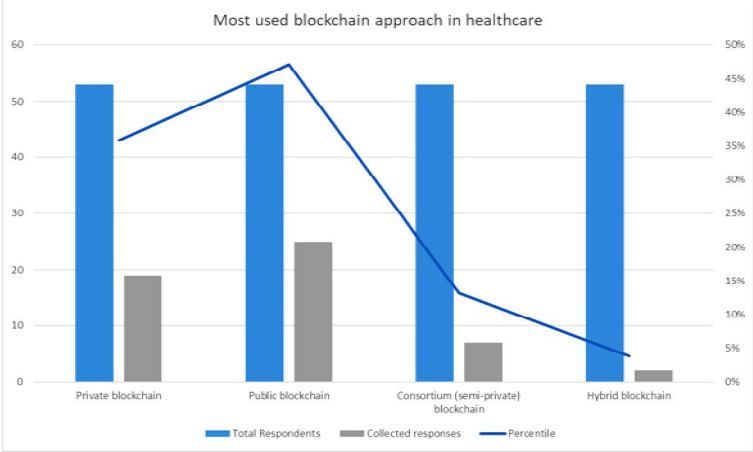

Figure 3. Graphical representation of the second survey question

Q3: Which blockchain technology do you think is most secure?
Responses

TABLE 3. RESPONSES OF SURVEY QUESTION 3

Options in the Google Form	Total Respondents	Collected responses	Percentile
Private blockchain	53	17	32%
Public blockchain	53	20	38%
Consortium (semi-private) blockchain	53	6	11%
Hybrid blockchain	53	10	19%

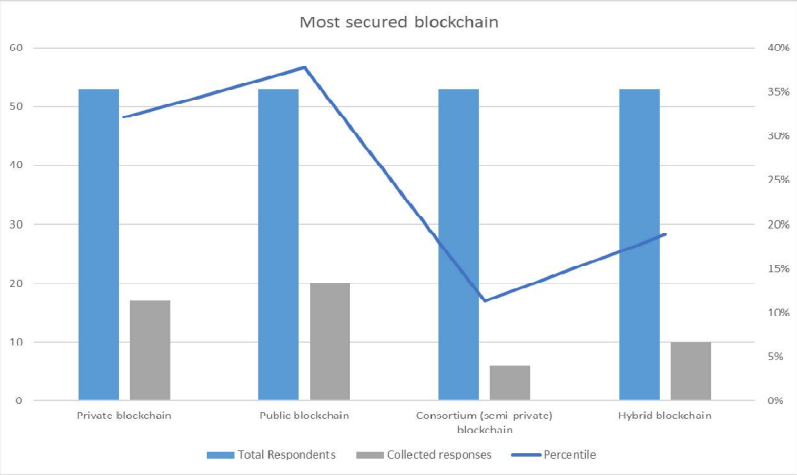

Figure 4. Graph of Survey Question 3 responses
(Source: Self-Created)

Table 3 and figure 4 suggest that 38% of the respondents agreed that public blockchain is more secure than any other blockchain. However, a private blockchain is stated secure by 32% of respondents. Few respondents (30%) have stated that hybrid blockchain is secure.

Q4: Do you think blockchain is a costly alternative to the conventional pen-paper approach?
Responses

TABLE 4. RESPONSES OF SURVEY QUESTION 4

Options in the Google Form	Total Respondents	Collected responses	Percentile
Highly agree	53	6	11%
Agree	53	9	17%
Neutral	53	13	25%
Not at all	53	9	17%
Cost may reduce with further development	53	16	30%

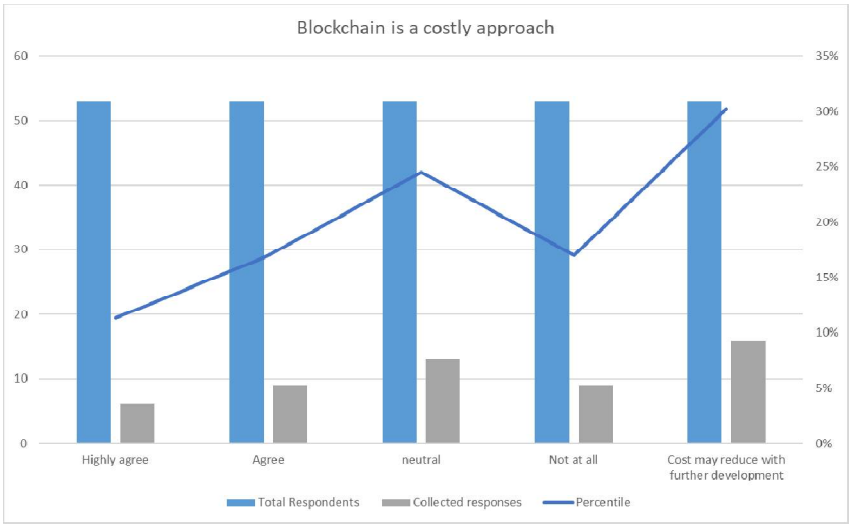

Figure 5. Graphical representation of Survey Question 4 responses

Survey question 4 is related to the possible challenge of blockchain technology, cost (table 4, figure 5). The respondents were neutral in most of the cases (25%). 28% of the respondents agreed that blockchain is a costlier technology than conventional pen-paper technology. 30% of respondents suggested that the cost can be reduced when the technology is improved further. Therefore, there is a conflict between these thoughts and knowledge which will be addressed in the discussion section.

Q5: Do you know any alternative technology of blockchain if the current technology fails?
Responses

TABLE 5. RESPONSES OF SURVEY QUESTION 5

Options in the Google Form	Total Respondents	Collected responses	Percentile
Cloud storage	53	13	25%
Decentralised storage	53	12	23%
Hashgraph	53	5	9%
Tangle	53	3	6%
No at all	53	20	38%

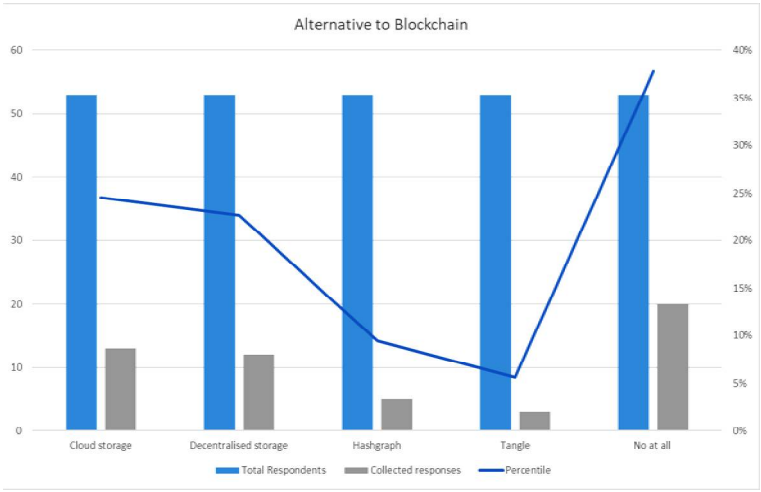

Figure 6. Graphical representation of Survey Question 5 responses
(Source: Self-Created)

The last survey question responses (table 5, figure 6) suggested that 38% of the respondents do not find an alternative for blockchain if this approach fails. However, 25% of respondents stated that cloud storage is an alternative followed by decentralised storage (23%), Hashgraph (9%) and Tangle (6%). Cloud storage may have certain security issues and other approaches may not be applicable in every field of medical data management.

DISCUSSION

The survey responses have provided empirical evidence against some research questions. However, a discussion is necessary to justify and judge the primary responses. Table 1 showed that most healthcare systems do not use the blockchain yet for securing and storing medical data. It suggests that, due to lack of proper training and knowledge in healthcare staff, the healthcare management system is not implementing this new technology [17]. Aguilera and colleagues suggested that expertise in blockchain training is required to successfully implement this technology. Usually, no technology is permanent and reports suggest many data breaches which cause a delay in successful implementation [18]. Shaverdian argued that blockchain is an ideal approach to manage sensitive medical data [19]. However, several pieces of research are also available that reported potential data breaches in sensitive medical data [20]. Concerning this, Dutta and Saini suggested, hybrid blockchain is a useful alternative to strengthen the security system in medium and small size businesses [21]. Moreover, this system is more productive than other blockchain taxonomies [22]. Therefore, hybrid or consortium blockchain is an advanced approach for securing medical data.

The survey responses suggest public and private blockchains are mostly used in healthcare, and consortium blockchain is also as famous as the other blockchains (table 2). Most of the respondents agreed that public blockchain is more secure than other blockchains. Studies also suggest that public blockchains are secured due to their authorisation by more than one person whereas private blockchain is limited to a few authorities where anonymous access is vulnerable [23]. On the contrary, Dutta and

Saini argued that hybrid blockchain is a new cost-effective and more secure approach for storing and sharing sensitive medical data. Moreover, the process is faster than the other blockchains [24]. One issue here is, this hybrid blockchain is productive and useful in small and medium-size healthcare sectors only. Therefore, for the large size sectors, more research is necessary to manage data securely. Probably, using AI in security monitoring will improve the hybrid blockchain for use in large sectors.

Survey question 3 responses stated that a blockchain is a costly approach that needs to be improved for reducing the cost of implementation. The cost may lie in the computer technologies and training management. Usually, training requires a large amount of data along with data management experts which ultimately increase the cost [25]. Hughes and colleagues suggest that before implementation of this technology, cost needs to be monetised along with the energy, time, computational cycles, security issues, limitation in bandwidth and size [26]. The higher costs are generated by these factors and thus, blockchain is implemented by considering them along with understanding the unintended outcomes as well.

Survey question 5 responses suggest that many of the respondents do not know any beneficial alternative for this blockchain approach. Most of them suggested cloud and decentralised storage systems. The cloud system is centralised and the blockchain is decentralised. Studies suggest that a decentralised or public-based blockchain system is more secure as more than one authority observes the activities in the system [27]. On the other hand, a centralised blockchain (private) or cloud storage system is less secure as unverified or anonymous access may cause data breaches in the private storage [28]. Concerning this, hybrid blockchain technology has arrived which will perform both as a private and public decentralised system to ensure maximum security along with faster execution at a lower cost.

AWS Amazon has launched a cloud system that is both centralised and decentralised to ensure multiple authorisations [29]. Therefore, cloud storage systems are shifting from a centralised version to a decentralised form. Thus, probably, the respondents have agreed that cloud storage can be a useful alternative to a decentralised blockchain. Moreover, the respondents agreed that decentralised storage is a demanding factor (table 5). Few of the respondents suggested *Hashgraph* and *Tangle* as the alternatives of blockchain. Regarding this, Wang and co-workers stated that Hashgraph is a next-generation blockchain technology to implement in several types of business [30]. Hashgraph is reported to be faster than other blockchains in terms of transaction and fairness. Tangle is another blockchain technology that also benefits the transaction platform. Moreover, this technology does not require miners and possesses zero transaction fees [31].

CONCLUSION

The paper has discussed an empirical analysis of blockchain technology in healthcare data management systems. The blockchain is used in data storing, sharing and securing sensitive medical data. After that these data are analysed securely. The study found that many healthcare sectors have not implemented blockchain technology yet. However, healthcare sectors that implemented this contain public and private blockchain. A hybrid blockchain is an advanced approach that is considered more secure than the other two blockchains. Among the respondents, few agreed that hybrid blockchain is being used in the healthcare sector. The hybrid blockchain is more productive as well in terms of data management. Apart from these, Hashgraph and Tangle are two next-generation blockchains that can be better alternatives to conventional blockchains. The research can be extended further to explore more on the next-generation blockchains.

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