



Influence of Advanced Blockchain technology on digital health interventions

Prabhakara Rao Kapula^{1,*}, N K Sakthivel², K K Ramachandran³, Gopal Ramchandra Kulkarni⁴, Nabamita Deb⁵

¹Professor, Department of ECE, B V Raju Institute of Technology, Narsapur. Telangana State

²Dean, Computer Science and Engineering, Nehru Institute of Engineering and Technology, Coimbatore, India

³Professor, Commerce/ Management Science, DR G R D College of Science, India

⁴Principal, Merchant Engineering College, Basna 384380, Gujarat, India

⁵Assistant Professor Department of Information Technology, Gauhati University

*Email : prabhakar.kapula@bvrit.ac.in

ABSTRACT

This research study clearly reflects the impacts of Blockchain technology on interventions of digital health and the major characteristics of this technology has been mentioned clearly in this context. The introduction part clearly describes the definition of Blockchain technology along with its major function in diverse filed. The key function of this technology on health care-related systems has also been analyzed in this section. The literature review part critically analyzes four major features of Blockchain technology along with its impacts on the health care sector. The other influential characteristics have also been evaluated in this context critically. After that, the various advancement in these technologies has also been mentioned that truly incentivize the incorporation of digital technologies in health sectors. The research methodology part also describes the detailed process of evaluating results about the impact of Blockchain technology on health care works. Analysis and interpretation reflect four tables and respective graphical representations of the survey results. The survey has occurred by taking 55 people. Among them some are patients and some are healthcare professionals. The discussion part analyzes the survey result as well as some real examples of Blockchain technology in health sectors. At last, a clear conclusion has been provided that supports the influence of this technology on "digital health interventions".

Keywords: Blockchain technology, Immutability, Decentralization, distributed ledger, consensus algorithm

Received 18.02.2022

Revised 20.03.2022

Accepted 02.04.2022

INTRODUCTION

Blockchain technology reflects a unique method through which diverse information can be easily recorded in a definite way. This technology is well developed and provides a huge level of protection to the information system. It is a unique kind of digital method by which transactions have been duplicated as well as distributed across the whole network of computer systems within the Blockchain [1]. It comprises a diverse kind of application such as compilation of huge amount of data on sales, tracking digital payments and various kinds of health care works. Many challenges have been observed in the field of appropriate patient care such as transparent interoperability, maintaining data privacy, and various kinds of technology-related issues, patient-centric data security, and proper governance of all kinds of work in the hospital and similar other managerial things. Those kinds of work have needed a huge level of accuracy as well as the accountability that can be easily provided by the implementation of unique Blockchain technology. Apart from that it also offers a huge level of patient-centric interoperability that has huge importance in all hospitals.

Immutability of the health care information that has been stored within a Blockchain hugely attracts attention and based on that information an appropriate discussion about the health condition can be achieved. Proper implementation of this Blockchain technology can easily improve the authentic management of several kinds of medical records as well as processes for claiming insurance [2]. It also hugely accelerates biomedical and different types of clinical research and also incentivizes the formation of a "healthcare data ledger".

The application of Blockchain technology totally depends on some useful characteristics of this unique technology. The major features are-decentralized management, data provenance, a huge improvement in

data privacy and security, immutable audit trailing and robustness in all kinds of similar work. In addition to all those unique things, the most important feature is the recovery of important health care data from a huge range of the dataset. All the medical data must be possessed as well as operated and along with that those data also has been allowed to be accessed by diverse data subjects [3]. Apart from all those things, with the help of this innovative technology patients can also acquire their health care data from any hospital all over the world.

This research study is going to explore a detailed idea about the influence of that innovative Blockchain technology on the invention of digital health programs.

LITERATURE REVIEW

Basic features of Blockchain technology

Blockchain technology comprises some unique characteristics that make it distinct compared to other innovative systems. Those features are-**Immutability** that reflects the data stored in the Blockchain cannot be easily modified or it can be stated that the modification is impossible. The stored data has been checked at fixed time intervals continuously and the information that is newly added after each checking is considered as a block. This network also consists of a huge number of nodes. Each node comprises a transparent copy of updated data. Due to tot his reason, the transparency has been committed successfully. Besides that, for modification of datasets, one needs to modify all sets of the node which is totally impossible. For all those reasons, healthcare-related data can be easily stored as there is no fear of data corruption or any kind of data cyber-attack by hackers [4]. Data privacy is one of the key factors for storing healthcare-related information. Blockchain technology clearly provides this feature.

Decentralization is considered the second important feature of Blockchain technology. The concept of decentralization reflects the information that has been stored within this technology acts as a specific unit of the overall network. No definite authority for centralization has been observed in it. Apart from that, all the information has stored inside nodes. The principles that have been acting behind its working principle can be called "peer to peer" or "user to user". Healthcare professionals steadily want to utilize this technology for its easy traceability characteristics [5]. This technology ensures data traceability in a short period of time while maintaining transparency. On the contrary, another research study has revealed that in spite of offering traceability it cannot provide huge transparency which can be a challenging matter. However, this problem can be mitigated through the implementation of artificial intelligence into it.

According to [6] enhanced data security is the core pillar of advanced Blockchain technology. A unique data protection procedure has been witnessed in this field that provides tight security of confidential health information of individuals. The information is stored inside it and is highly secured with the public as well as private keys. Public keys are essential for sharing data with the public and the private key is needed for accessing data by the user. Due to these unique processes, the confidential data can be easily stirred without any risk. Health-related data has huge importance and hacking of that data can hamper the ethics of an individual. Due to this reason, there is a huge need for the implementation of Blockchain technology and immediate incorporation of this technology is needed along with other healthcare-related machinery.

On the other hand, according to [7] "distributed ledger" is also another kind of important characteristic that improvises the sharing of important datasets several times among all the nodes indulged into it. A unique feature of Blockchain technology that is self-up gradation at 10 minutes time intervals is considered as one of the major characteristics of this technology. Diverse information that has been kept inside it can be considered as a shared file. The information that has been shared can also be verified easily and also accessed by health care professionals based on their need for detailed analysis. Along with that this innovative technology also ensures a wide range of data protection along with easy synchronization with other files that existed into it. The absence of any kind of central point ensures data privacy as well as security.

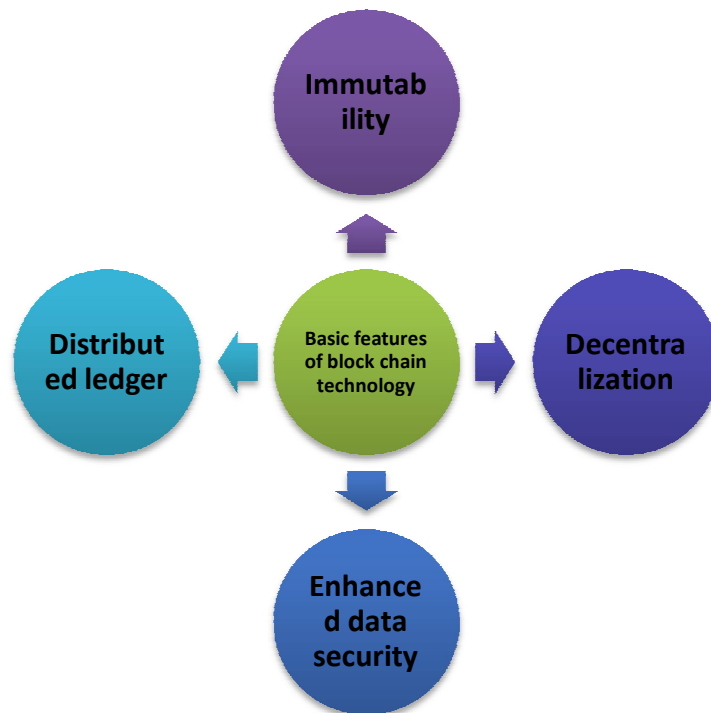


Figure 1: Basic features of Blockchain technology
(Source: Created by the researchers)

Influential characteristics of Blockchain technology

According to [8] apart from all those four important characters the other two important features are "faster rate of settlement" and "consensus". These two important features assist people to make an easy transaction as well as making quick decisions about a confidential matter of healthcare. Consensus reflects the unique and easy process of decision making through the group of nodes. The consensus majorly incorporates an algorithm inside it that helps to make transparent as well as the authentic interconnection between the nodes. This consensus algorithm varies among diverse technologies inside an organization. On the contrary, according to [9] patient care can be easily acquired through spending a significant amount of money from any part of the world securely and at a faster rate.

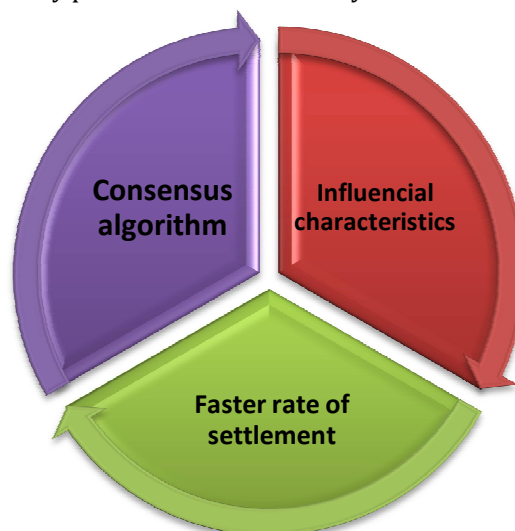


Figure 2: Influential characteristics of Blockchain technology
(Source: Created by the researchers)

Advancement of Blockchain system and impact on digital health interventions

Healthcare-related technologies must have comprised some important features such as quick response, verification of upgraded data, effective management of information as well as data security. All those

things have been transparently provided by this technology [10]. Apart from that, less failure, proper user control behavior, less possibility to break down, absence of any kinds of scams makes this unique technology reliable to most health care professionals.

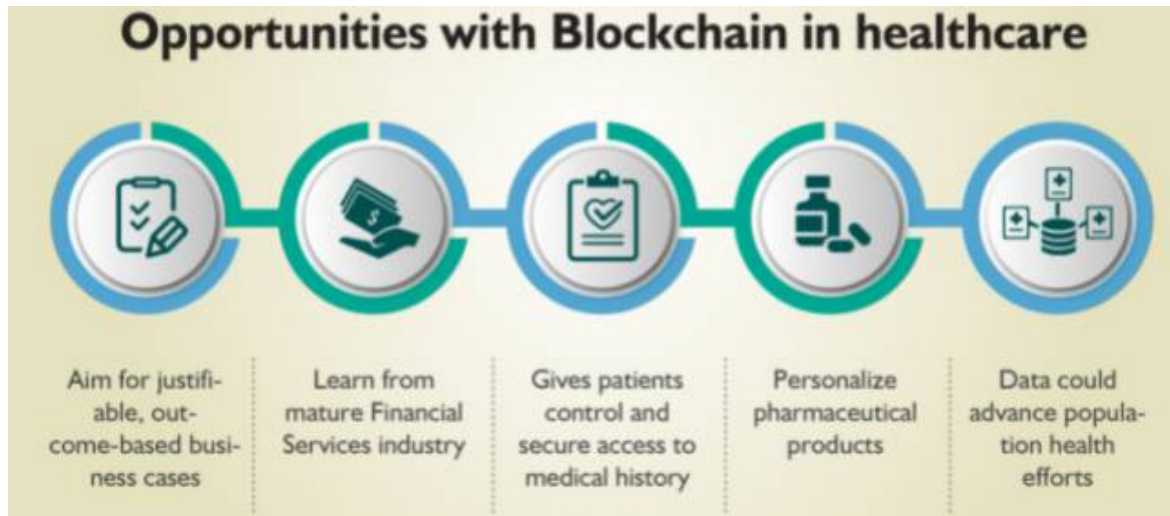


Figure 3: Blockchain opportunities in healthcare
(Source: [11])

Less failure reflects an authentic level of organization among all the information. This technology is not dependent on the human calculator and due to this; system failure or improper result cannot be a probable output. Due to containing the property of decentralization, there is a huge possession of one's own property. Due to this reason, users can easily access their information at any time. Thus, a huge level of user control property has been observed. Along with that as it comprises the property of decentralization, it possesses less vulnerability to diverse kinds of malicious attacks. Due to this reason this technology is less vulnerable to any kind of failure. One of the important characteristics of this system is the absence of any kind of third-party accession [11]. Due to this reason, it can be stated that users can flexibly access their own data without allowing any kind of third-party appearance in their portal. Apart from all those things, this system totally runs on a unique algorithm there is less chance for the occurrence of any kind of scam. Due to all those reasons, the incorporation of Blockchain technology is essential along with various digital inventions of health care.

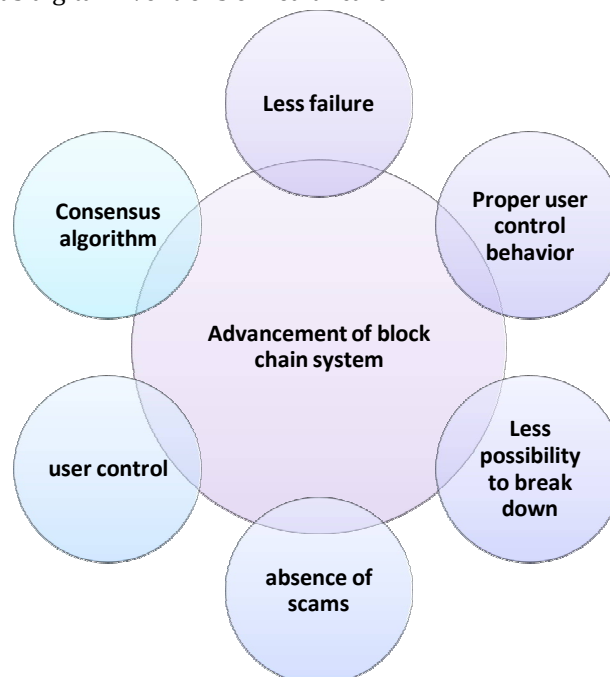


Figure4:Advancement of Blockchain system
(Source: Created by the researchers)

RESEARCH METHODOLOGY

Research methodology defines various kinds of processes through which a unique result can be obtained based on the impact of Blockchain technology on interventions of digital health. Apart from that it also hugely supports the construction of the actual objectives of the research study. Based on the research methodology the discussion can be obtained. In this research study, a quantitative research approach has been followed where 25 health care professionals and 30 random people have been selected from different hospital areas and a survey has been conducted to evaluate the impact of Blockchain technology on the intervention of digital health programs [12]. In addition to this, through those survey questions, a transparent assessment has occurred to obtain the knowledge of those individuals about the pros and cons of Blockchain technology. Besides that, questions have also been asked to address the necessity of it among those professionals.

The question also asked to know the acceptance of this technology among random patients. Due to the user-friendly character of this technology, there is a huge expectation of positive results present from their end. The data collection procedure comprises some following steps such as the formation of a unique survey team, going to various hospitals for organizing survey, asking various types of questions to assess the knowledge about Blockchain technology, maintenance of authentic records, analysis of the data extracted from the survey, making discussions after critical analysis of those results, aligning with the objective of the research study. Those all processes have been obtained through a chain a manner and one after another with giving a significant amount of time. In this research study mainly the quantitative research approach has been followed and the secondary resources also have been analyzed to give support the result obtained from quantitative analysis.

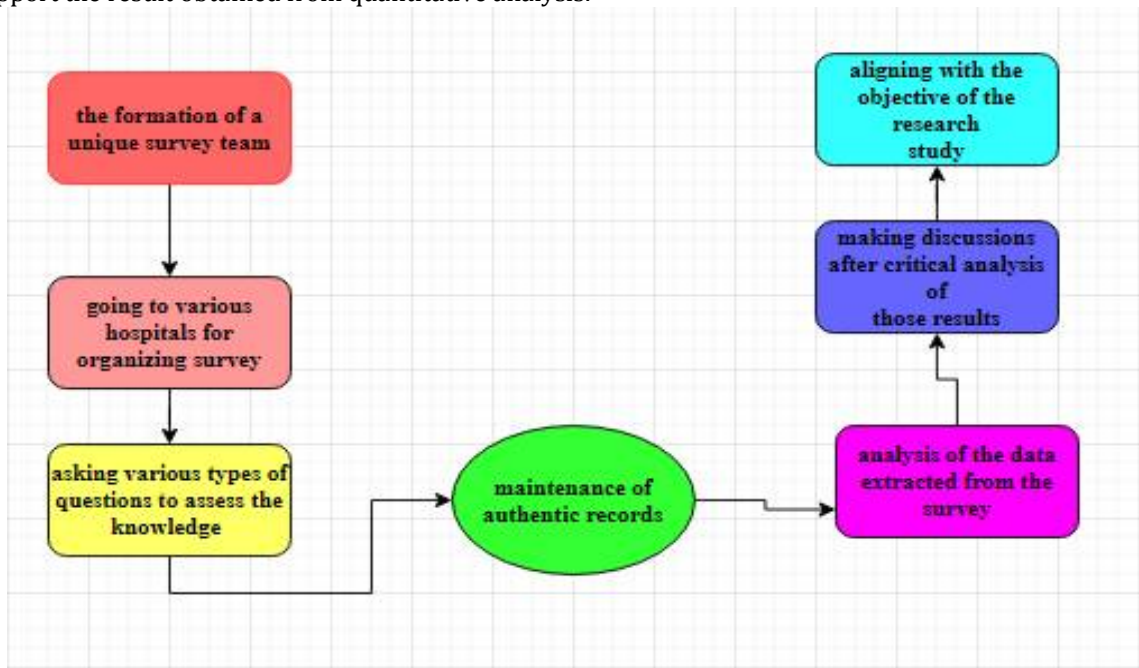


Figure 5: Detailed process of data collection

(Source: Created by the researcher)

ANALYSIS AND INTERPRETATION

Analysis, as well as interpretation, is a major area of any kind of research study as it is the backbone of the research study. A transparent analysis assists in understanding the possible ways through which the objectives and real-life advantages can be extracted easily. Based on the topic of this research study, a broad range of advantages can be observed in the health care sector [13]. The current global condition is totally based on the effective utilization of digital technologies, flexible, forward-moving, highly adaptable and truly accountable. Due to all those reasons, it is important to keep pace with the current world of digitization [14]. Apart from this, the health sector is one of the most crucial sectors and there is a huge need for digitization to enhance its processing speed and decision making speed. Along with that, transparent analysis of health information helps in-depth analysis about one's health consequences. Besides that, there is a huge need to maintain data privacy and it cannot be shared with any third persons due to data misuse [15]. This technology ensures protection against any unauthorized personality to access one's confidential data. After evaluating the research topic two research questions have been raised.

Research questions

- What are the major characteristics of Blockchain technology that influence "digital health interventions"?
- What are the processes through which Blockchain technology imparts benefits to health care professionals along with other digital technologies?

Research survey questionnaires:

Question 1: Do you know the diverse characteristics of Blockchain technology related to health care?

TABLE 1: DIVERSE CHARACTERISTICS OF BLOCKCHAIN TECHNOLOGY RELATED TO HEALTH CARE
(SOURCE: CREATED BY THE RESEARCHERS)

Question 1			
Options provided	Number of survey individuals	Number of responses	Respective percentage
yes I have clear knowledge	55	20	40
I know some major features	55	20	40
I don't have a clear idea	55	10	20
I don't know anything about this	55	5	10

According to this table, it has been clearly stated that most of the survey individuals comprise brief ideas about the major characteristics of Blockchain technology in the field of healthcare. Among 55 persons only 5 persons exist who do not comprise any idea about this technology.

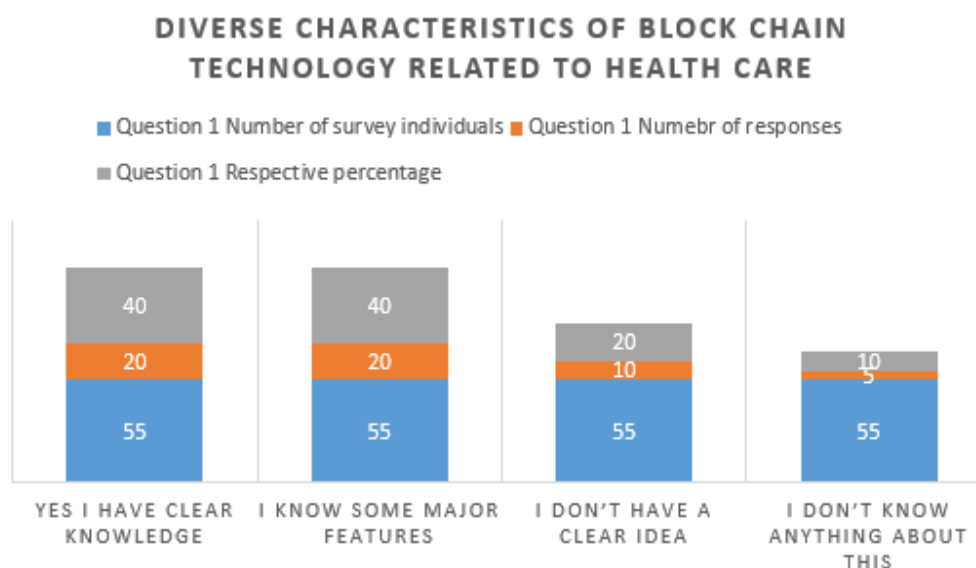


Figure6: Diverse characteristics of Blockchain technology related to health care
(Source: Created by the researchers)

The above graph shows the relative percentages of the survey individuals where it has been reflected that 40 % of the total persons have a clear idea about important features of Blockchain technology in respect to healthcare.

Question 2: Do you have any idea about the utilization process of Blockchain technology managing healthcare-related programs?

TABLE 2: UTILIZATION PROCESS OF BLOCKCHAIN TECHNOLOGY MANAGING HEALTHCARE-RELATED PROGRAMS
(SOURCE: CREATED BY THE RESEARCHERS)

Question 2			
Options provided	Number of survey individuals	Number of responses	Respective percentage
yes, I have a transparent idea	55	20	40
I know some of those processes	55	15	30
I don't have any clear idea	55	10	20
I have no idea about this process	55	10	20

According to the above table, it can be stated that most persons have clear knowledge about the utilization process of Blockchain technology. There is a total of 20 people who have no clear idea about the utilization process.

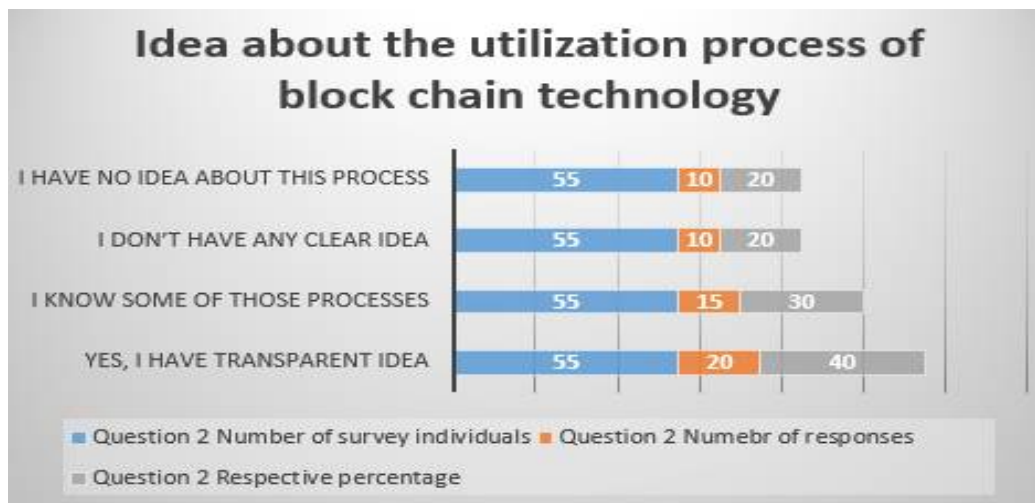


Figure7: Utilization process of Blockchain technology managing healthcare-related programs
(Source: Created by the researchers)

As per the above graph, it can be stated that 40 % of survey individuals have a clear idea about the utilization process of Blockchain technology and there is a huge difference present between the person who has no idea about the utilization process.

Question 3: Do you think Blockchain technology can be used as a reliable system that hugely influences "digital health interventions"?

TABLE 3: BLOCKCHAIN TECHNOLOGY CAN BE USED AS A RELIABLE SYSTEM
(SOURCE: CREATED BY THE RESEARCHERS)

Question 3			
Options provided	Number of survey individuals	Number of responses	Respective percentage
yes, I think it is a reliable system	55	40	80
I have less knowledge about its reliability	55	10	20
It is not too reliable	55	5	10

According to the above table, 40 individuals replied with a strong positive response and think the Blockchain technology was a reliable system and only 5 people comprise a negative response.

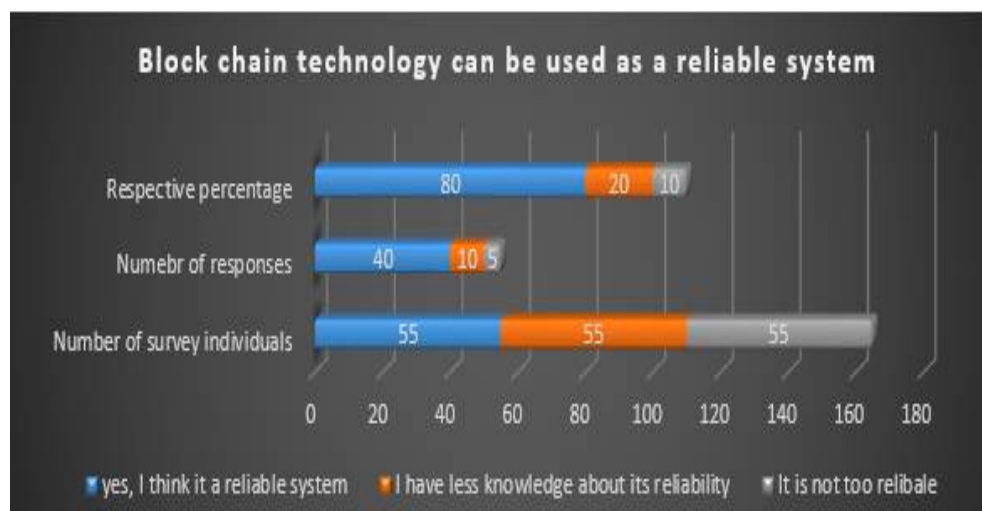


Figure8: Blockchain technology can be used as a reliable system
(Source: Created by the researchers)

As per the graphical representation, it can be said that 80% of survey persons have strong positive responses and only 10% of people has shown negative response who have answered: "it is not too reliable".

Question 4: Can Blockchain technology ensure data privacy as well as security during the storage of that information or sharing with authentic persons?

TABLE 4: BLOCKCHAIN TECHNOLOGY ENSURE DATA PRIVACY AS WELL AS SECURITY
(SOURCE: CREATED BY THE RESEARCHERS)

Question 4			
Options provided	Number of survey individuals	Number of responses	Respective percentage
yes, it hugely ensures data privacy	55	30	60
It partially offers data security	55	20	40
It does not ensure data privacy	55	5	10

As per the above table, it has been revealed that 30 survey individuals have a clear trust in the data privacy character of Blockchain technology. Along with that, only 5 individuals have opinions about the absence of authentic data privacy character.

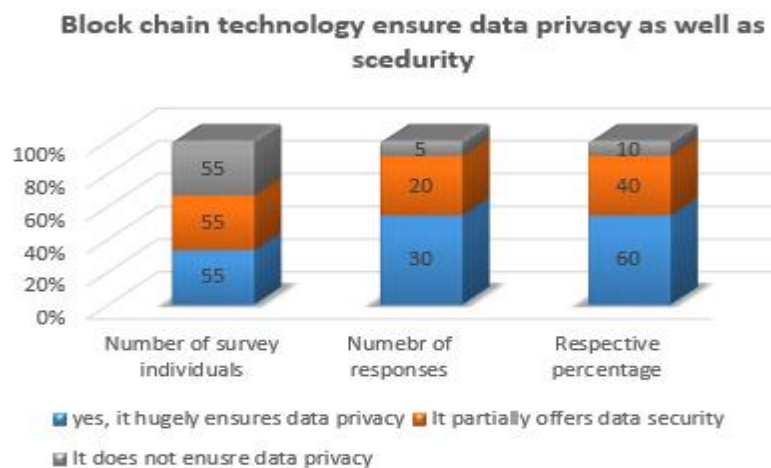


Figure9: Blockchain technology ensure data privacy as well as security
(Source: Created by the researchers)

According to the above graph, it can be said that 60% of total survey persons comprise huge positive responses and this percentage is huge compared to the persons who have answered: "it does not ensure data privacy".

DISCUSSION

The discussion parties hugely support the obtaining survey result that shows a clear positive response to the effectiveness of Blockchain technology compared to the other innovative digital technologies. The efficiency, as well as the flexibility of this unique system, has been supported through the survey result that also highlights the possible benefits of it in the field of quick money transactions as well as short time decision making [16].

Blockchain technology has a huge impact on healthcare due to its three major characteristics and those are incorruptible, transparent as well as decentralized behavior [17]. It helps the generation of unique codes through which data has been secured and cannot be accessed by third parties. The decentralization process assists in sharing similar kinds of information to healthcare individuals such as doctors, patients, other staff safely and also in a short time. Some real examples have been figured out in this context [18].

A big data analytics organization called Akiri utilizes this technology for protecting health-related information during the time of transportation. It cannot store any kind of information. It actually operates as a network system and also improvises diverse kinds of policies as well as constructing unique layers of

data during the time of verification of possible sources [19]. It also assists in reaching data in a definite destination in real-time.

The main importance of this system is it ensures data sharing only with authentic individuals and it also ensures data privacy. Along with that, it allows access only when the authentic individuals have the necessity of that information [20].

BurstIQ is also another organization that provides cyber security and also analyzes big data. This organization assists in managing a massive amount of health-related information of the patient's individuals safely. This unique industry offers safeguarding, sharing, and managing data with strict maintenance of Government rules [21]. This organization truly helps authentic sharing as well as utilization of updated information. Due to this reason, a clear and appropriate idea can be easily gained through the updated prescriptions.

Another type of industry named Factom incorporates Blockchain technology to provide safe storage of digital records of the patients. The storage of that health care-related information allows only the authentic individuals to access that information [22]. The authentic individuals include doctors, nurses, patients and other health professionals. Physical papers also can be equipped by using a definite microchip where all the records have been stored successfully and those stored data can be accessed only by the authorized persons in real-time [23].

The last example is Guard time which is an industry of cyber security maintenance that offers a huge level of protection against diverse kinds of hacking incidents. It hugely incorporates mechanisms that ensure tight data protection and resist any kinds of cyber misuses [24].

CONCLUSION

After evaluation of the whole research study, it can be concluded that Blockchain technology has a huge positive impact on the enormous incorporation of digital processes in the health sector along with this innovative technology. There is a huge level of important characteristics that allow providing a transparent level of data security along with a proper mechanism of data storage. Health-related data is considered the most confidential one among other types of personal information as it reflects the overall health scenario of a large group of individuals [25]. Several mis-conductance can be observed if those data cannot be stored or analyzed properly. A comprehensive interlinking has been observed between the data analysis and making of critical decisions based on those analyses. A clear survey has also occurred that is mentioned in the analysis and interpretation context. This survey result truly supports the advantages of using Blockchain technology in the intervention of digital health. In the discussion part, some real-life examples have also been given that reflect the proper storage, sharing, accessing as well as decision making based on the health information [26]. At last, it can be concluded that there is a huge need for the incorporation of Blockchain technology for "digital health interventions".

REFERENCES

1. Liu, W., Zhu, S.S., Mundie, T. and Krieger, U., (2017), October. Advanced block-chain architecture for e-health systems. In *2017 IEEE 19th International Conference on e-Health Networking, Applications and Services (Healthcom)* (pp. 1-6). IEEE.
2. Ichikawa, D., Kashiwayama, M. and Ueno, T., (2017). Tamper-resistant mobile health using Blockchain technology. *JMIR mHealth and uHealth*, 5(7), p.e7938.
3. Kolasa, K. and Kozinski, G., (2020). How to value digital health interventions? A systematic literature review. *International Journal of Environmental Research and Public Health*, 17(6), p.2119.
4. Labrique, A., Vasudevan, L., Weiss, W. and Wilson, K., (2018). Establishing standards to evaluate the impact of integrating digital health into health systems. *Global Health: Science and Practice*, 6(Supplement 1), pp.S5-S17.
5. Leeming, G., Cunningham, J. and Ainsworth, J., (2019). A ledger of me: personalizing healthcare using Blockchain technology. *Frontiers in medicine*, 6, p.171.
6. Patil, A., Shardeo, V., Dwivedi, A. and Madaan, J., (2020). An integrated approach to model the Blockchain implementation barriers in humanitarian supply chain. *Journal of Global Operations and Strategic Sourcing*.
7. Chehade, M.J., Yadav, L., Jayatilaka, A., Gill, T.K. and Palmer, E., (2020). Personal digital health hubs for multiple conditions. *Bulletin of the World Health Organization*, 98(8), p.569.
8. Sandner, P., Lange, A. and Schulden, P., (2020). The role of the CFO of an industrial company: an analysis of the impact of Blockchain technology. *Future Internet*, 12(8), p.128.
9. Ullah, N., Mugahed Al-Rahmi, W., Alzahrani, A.I., Alfarrarj, O. and Alblehai, F.M., (2021). Blockchain technology adoption in smart learning environments. *Sustainability*, 13(4), p.1801.
10. Al-Saqaf, W. and Seidler, N., (2017). Blockchain technology for social impact: opportunities and challenges ahead. *Journal of Cyber Policy*, 2(3), pp.338-354.
11. Zarour, M., Ansari, M.T.J., Alenezi, M., Sarkar, A.K., Faizan, M., Agrawal, A., Kumar, R. and Khan, R.A., (2020). Evaluating the impact of Blockchain models for secure and trustworthy electronic healthcare records. *IEEE Access*, 8, pp.157959-157973.

12. Sharma, R., Zhang, C., Wingreen, S.C., Kshetri, N. and Zahid, A., (2019). Design of Block chain-based precision health-care using soft systems methodology. *Industrial Management & Data Systems*.pp89.
13. Angraal, S., Krumholz, H.M. and Schulz, W.L., (2017). Blockchain technology: applications in health care. *Circulation: Cardiovascular quality and outcomes*, 10(9), p.e003800.
14. Clauson, K.A., Breeden, E.A., Davidson, C. and Mackey, T.K., (2018). Leveraging Blockchain Technology to Enhance Supply Chain Management in Healthcare:: An exploration of challenges and opportunities in the health supply chain. *Blockchain in healthcare today*.
15. Tsolakis, N., Niedenzu, D., Simonetto, M., Dora, M. and Kumar, M., (2021). Supply network design to address United Nations Sustainable Development Goals: A case study of Blockchain implementation in Thai fish industry. *Journal of Business Research*, 131, pp.495-519.
16. Ahram, T., Sargolzaei, A., Sargolzaei, S., Daniels, J. and Amaba, B., (2017), June. Blockchain technology innovations. In 2017 IEEE technology & engineering management conference (TEMSCON) (pp. 137-141). IEEE.
17. Till, B.M., Peters, A.W., Afshar, S. and Meara, J.G., (2017). From Blockchain technology to global health equity: can cryptocurrencies finance universal health coverage?. *BMJ global health*, 2(4), p.e000570.
18. Gordon, W.J. and Catalini, C., (2018). Blockchain technology for healthcare: facilitating the transition to patient-driven interoperability. *Computational and structural biotechnology journal*, 16, pp.224-230.
19. Mamoshina, P., Ojomoko, L., Yanovich, Y., Ostrovski, A., Botezatu, A., Prikhodko, P., Izumchenko, E., Aliper, A., Romantsov, K., Zhebrak, A. and Ogu, I.O., (2018). Converging Blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. *Oncotarget*, 9(5), p.5665.
20. Mackey, T., Bekki, H., Matsuzaki, T. and Mizushima, H., (2020). Examining the potential of Blockchain technology to meet the needs of 21st-century Japanese health care: viewpoint on use cases and policy. *Journal of medical Internet research*, 22(1), p.e13649.
21. A. Jain, A. K. Yadav & Y. Shrivastava (2019), "modelling and optimization of different quality characteristics in electric discharge drilling of titanium alloy sheet" material today proceedings, 21, 1680-1684
22. A. Jain, A. K. Pandey, (2019), "Modeling And Optimizing Of Different Quality Characteristics In Electrical Discharge Drilling Of Titanium Alloy (Grade-5) Sheet" Material Today Proceedings, 18, 182-191
23. A. Jain, A. K. Pandey, (2019), "Multiple Quality Optimizations In Electrical Discharge Drilling Of Mild Steel Sheet" Material Today Proceedings, 8, 7252-7261
24. Panwar, D.K. Sharma, K.V.P.Kumar, A. Jain & C. Thakar, (2021), "Experimental Investigations And Optimization Of Surface Roughness In Turning Of EN 36 Alloy Steel Using Response Surface Methodology And Genetic Algorithm" Materials Today: Proceedings, <https://doi.org/10.1016/j.matpr.2021.03.642>
25. A. Jain, C. S. Kumar, Y. Shrivastava, (2021), "Fabrication and Machining of Metal Matrix Composite Using Electric Discharge Machining: A Short Review" Evergreen, 8 (4), pp.740-749
26. A. Jain, C. S. Kumar, Y. Shrivastava, (2021), "Fabrication and Machining of Fiber Matrix Composite through Electric Discharge Machining: A short review" Material Today Proceedings. <https://doi.org/10.1016/j.matpr.2021.07.288>

CITATION OF THIS ARTICLE

P R Kapula, N K Sakthivel, K K Ramachandran, G R Kulkarni, N Deb. Influence of Advanced Blockchain technology on digital health interventions. Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022 : 273-282